With METALLURGICAL SUPPLEMENT.

The Engineer.

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VOL. CLII.—No. 3963] LONDON: FRIDAY EVENING, DECEMBER 25, 1931 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES.

Woolwich Polytechnic.

The Governors invite APPLICATIONS for the POST of PRINCIPAL of the POLYTECHNIC, to commence work on 1st September, 1932. Candidates must have good honours degrees and actual experience in organisation and administration in a technical institute or university college. Salary in accordance with the scale £960, rising by increments of £50 to £1200 per annum, less 10 per cent., subject to any revision which may take effect after 31st March, 1932.

Further particulars and forms of application may be obtained by sending a stamped addressed envelope to the undersigned. Applications must be returned by 23rd January, 1932.

Canvassing, direct or indirect, of the Governors will disqualify a candidate.

A. J. NAYLOR,
Clerk to the Governors.

Woolwich Polytechnic,
Woolwich, S.E. 18,
14th December, 1931. 7934

Bengal Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for :—

1000 STEEL CARRIAGE AND WAGON TYRES.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after Monday, 21st December, 1931.

A fee of 10s. will be charged for each copy of the specification, which is NOT returnable.

Tenders must be submitted not later than Noon on Monday, 11th January, 1932.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
R. GRANT,
7930 Secretary.

River Medway Catchment BOARD.

LAND DRAINAGE ACT, 1930.
ENGINEER'S DEPARTMENT.

APPLICATIONS are INVITED to fill the following POSTS :—

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(b) DRAUGHTSMAN, commencing salary £155 per annum, rising by annual increments of £15 (subject to satisfactory service) to a maximum of £200 per annum.

Applicants for the above posts must have had experience in either the construction, maintenance or design of River and Land Drainage Works, including Sea and River Walls and Embankments, Arterial Drains, Sluices, Locks, &c.

The Board have resolved to adopt the Local Government and Other Officers' Superannuation Act, and the appointment will be subject to the provisions of this Act, as soon as the necessary Order has been made.

Forms of application may be obtained from me on sending a foolscap stamped addressed envelope to this office.

Applications, on the official forms, must be accompanied by not more than three recent testimonials, and should be received by me not later than Saturday, the 23rd January, 1932.

P. T. BAKER,
Clerk to the Board.

21st December, 1932.
71a, Bank-street, Maidstone, Kent. 7938

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The Engineer

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SITUATIONS OPEN.

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No. 289,708, for "Improvements in and relating to Spool or Cop Cores for Spool or Cop Dyeing;"
No. 296,603, for "Improved Process of and Device for Mounting Textile Bobbins to be Dyed in Columns,"

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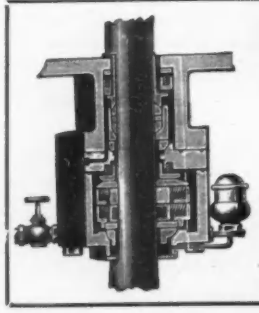

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A Seven-Day Journal

Bunker Coal.

IN a letter to *The Times* of December 21st, 1931, Alfred Holt and Co., Ltd., of Liverpool, state that the quota and price restrictions under Part I. of the Coal Mines Act have a most damaging effect upon coal-burning ships using the Port of Liverpool. It is alleged that the tendency of these restrictions has been to increase bunkering costs at Liverpool by throwing the Liverpool market upon the high-priced supplies of the Lancashire, North Wales and North Staffs. coalfields, and removing from it the lower-priced supplies of the nearer and larger coal-fields of Yorkshire, with the result that coal-burning ships using the Port of Liverpool are obliged often to seek their main supplies of bunkers elsewhere, to the frequent upset of their loading arrangements and to the grave prejudice of the Port of Liverpool, the second port of the United Kingdom. Why, it is asked, should the hard-hit shipping trade of Liverpool be subjected to the arbitrary interferences of this purely selfish legislation? It is pointed out, furthermore, that one of the other curious results of these manipulations is, for example, that Durham coal at times can be obtained in Rotterdam at a slightly lower price than similar quality coal at Liverpool, and a ship lying at Rotterdam and proceeding *vid* Liverpool is consequently driven into coaling at Rotterdam. Thus the labour and plant in Liverpool lie idle while Rotterdam does the work and receives the dues.

North Atlantic Traffic.

IT is already known that there was a very large decline in the number of passengers crossing the Atlantic during the year, but figures just published demonstrate that the decline was even greater than might have been expected. For the first eleven months of 1931 the number of West-bound passengers carried in vessels trading across the North Atlantic was 300,000, as compared with 540,000 in the corresponding period of 1930, a decrease of no less than 240,000. It is estimated that this reduction represents a decrease of about £7,250,000 in fares. Although no figures are available as to the decline in East-bound traffic, there is no doubt that it also was large. The decrease in the number of passengers carried was distributed over all classes, the figures for 1931 and 1930 being as follows:—First-class, 53,000 and 71,000; cabin, 47,000 and 80,000; second-class, 19,000 and 39,000; tourist, 95,000 and 133,000, and third-class, 86,000 and 216,000 respectively. The decline in third-class traffic was largely caused by the fact that America and Canada were not so open to emigrants as before, but, although tourist traffic fell sharply it still remained the most popular. As far as the three British companies trading across the North Atlantic are concerned, the decrease in West-bound passengers fell from 271,000 to 132,000, while the figures for continental lines were 232,000 to 150,000, and for Scandinavian 86,000 to 18,000.

Miss England the Third.

IN a Journal note of December 11th we referred to Lord Wakefield's statement at the Authors' Club dinner on December 7th that there would be a "Miss England the Third." On Friday last, December 18th, the announcement was made that this new racing boat will be designed and built by John I. Thornycroft and Co., Ltd. at the Hampton Launch Works on the Thames. Messrs. Thornycroft have contracted to design and build the hull in close collaboration with Rolls-Royce, Ltd., of Derby, which firm will supply and install the propelling machinery. She is to be propelled by two 1931 type engines similar to those which were fitted in the Schneider Trophy seaplane in which Flight-Lieutenant Stainforth won the world's air speed record at Calshot on Tuesday, September 29th, when an average speed of 408·8 miles per hour was recorded. Before the final lines of the boat are decided upon exhaustive tank tests, we are given to understand, will be carried out. It is expected that "Miss England III." will be completed and delivered to Lord Wakefield during April, 1932. Mr. Kaye Don is to be her pilot in further attempts to raise the world's water speed record. The announcement is also made that Mr. Kaye Don will compete in the races for the D'Annunzio Trophy on Lake Garda in Italy and the Harmsworth Trophy in America.

Agricultural and General Engineers.

THREE members of the board of Agricultural and General Engineers, Ltd., and seven directors of associated companies within the group, have signed a circular letter stating that they and their friends own more than one million shares in the company, and that on October 27th last they sent a memorandum to the board calling attention to the present serious state of affairs and requesting an immediate investigation of the state of the company by Sir Gilbert Garnsey. The signatories are Messrs. G. M. Blackstone, T. Aveling, E. Bentall, E. J. Barford, W. G. Barford, E. E. Blackstone, H. V. Blackstone, L. Turner, James Howard and C. E. Bentall. It is stated in the circular letter that the directors refused to accede to the request contained in the memorandum, although, subsequently, a resolution was passed authorising the chairman to invite an accountant to advise on the accounts of the company. The signatories of the circular letter do not consider that this action is satisfactory and maintain that no improvement in the company's affairs can be expected unless a complete investigation is undertaken by an independent authority. They state that they are actively engaged in the business and that some are directors of the three most successful groups—Blackstone and Co., Ltd., Barford and Perkins, Ltd., and Aveling and Porter, Ltd.—and that the profits made by these businesses have never reached the shareholders owing to the fact that the dividends have been swallowed up by the heavy expenses of the company, which has paid no dividend for eleven years. A reconstruction scheme seems to be inevitable and, in consequence, they consider that their recommendation with regard to the complete investigation should be carried out without delay. * * * Since the issue of the above circular an official circular has been sent to the shareholders by the company stating that Lord Plender has been requested to advise with the board, which has also asked Sir Gilbert Garnsey to co-operate with him. The signatories of the first circular have issued another pointing out the differences between their proposals and those of the board.

The New Cunard Liner.

THE following official statement was issued by the Cunard Steamship Company, Ltd., from Liverpool on Monday, December 21st:—"The Cunard Company continues to receive many communications from the general public over the suspension of No. 534, which are indicative of the universal interest taken in the question by all classes of society throughout the country. While these lead to the conclusion that there is ample evidence of a very widespread desire to see the work recommenced as soon as possible, the directors feel that until there is some clearing of the immediate economic and monetary difficulties which beset the commercial interests of the country, it would not be prudent to consider a resumption of the building of the ship except on an orthodox basis. The public may rest assured that the company will continue to maintain its traditional and well-tried methods in financing, and resume its construction at the earliest possible moment consistent with this policy." A trade union deputation numbering some thirty members of the Federation of Engineering and Shipbuilding Trades, the Boilermakers' Society, and the Amalgamated Engineering Union, headed by Mr. W. Sherwood, of the General and Municipal Workers' Union, called upon the President of the Board of Trade, on Tuesday afternoon, December 22nd, when suggestions for financing the construction of the ship were put forward. The deputation was introduced by Mr. Will Thorne, and, in the absence of Mr. Runciman, was received by Sir Charles Hipwood, the Second Secretary of the Board of Trade. Mr. Sherwood presented a statement which was supplemented by further statements by Mr. Frank Smith and Mr. Westwood. In his reply Sir Charles Hipwood said that he would convey to the President of the Board of Trade what the deputation had put before him, and a reply would, no doubt, be sent in due course. The question of repairing British ships in foreign ports was also raised, and the hope was confidently expressed that British shipowners would cause repairs to be carried out at home whenever possible.

Low-Temperature Carbonisation.

AT a luncheon given in honour of the Italian scientist Commendatore Piero Salerni, towards the end of last week, in London, Sir Eric Hambro referred to the recent paper read by Signor Salerni and Professor Wheeler at the Third International Congress on Bituminous Coal, held in Pittsburg. That paper had, he remarked, given full particulars of the Salerni low-temperature carbonisation process, from which, he said, it was not difficult to conclude that by that process the admittedly difficult problem of low-temperature carbonisation had been effectually solved. In it he saw the salvation of our once great coal industry, and he had decided that he himself, without either Government or public assistance, would shoulder the responsibility for the provision of the initial capital for its commercial development. With that end in view, Sir Eric has since stated that he intends early in the New Year to make a tour of the principal British mining centres in order to confer with colliery proprietors, miners' officials, and industrialists with a view to ascertaining all the local conditions, so that eventually a low-temperature carbonisation centre can be set up. Before long, Sir Eric hopes to have this new industry in full swing. The process for the production of petrol from coal used by Imperial Chemical Industries, Ltd., was described by Mr. K. Gordon at a meeting of the Midland Institute of Mining Engineers, held in Sheffield. While speaking in the discussion of his own paper on "The Hydrogenation of Coal" at a meeting of the North of England Mining and Mechanical Engineers. Dr. A. Crawford put forward a strong plea for Government support in research work. A figure of 40 per cent. for ships now using oil as fuel was given, and it was recalled that oil fuel was almost without exception used in the British Navy. If the support given to research work was satisfactory there was a hope, he thought, that this country could be made entirely self-supporting as regards fuel.

German Industrial Difficulties.

LAST week the A. Borsig G.m.b.H., of Berlin-Tegel, posted notices to the effect that the works would be closed down forthwith. More than 2500 employees are thus deprived of work, while it is expected that the office and technical staffs will receive notices to cease work at the end of the year. About 200 men have been retained in order to complete current contracts, but there would appear to be some difficulty even then, owing to the difficulty of obtaining materials from sub-contracting firms. A statement issued by the firm, which, it may be recalled is one of the oldest firms of engineers in Germany, states that the closing down has been necessary in order to carry out an inventory in the interests of the creditor firms. Hope is expressed that the closing down may only be a temporary measure. With regard to the statement which appeared in the daily Press to the effect that the firm of Henschel and Sohn A.G., of Cassel, is closing down at the end of the year, we are officially informed that this is only a temporary measure, and it is anticipated that the works will re-open three months hence. The necessity for closing down was caused, on the one hand, by the world-wide cancellation or postponement of railway building programmes; while, on the other hand, the firm wishes to take advantage of this lull in business to reorganise its three works at Cassel with a view to adapting them to meet the somewhat changed requirements of the present time.

A New Communication Service.

A SYSTEM of communication between business establishment, which seems to resemble a scheme described in THE ENGINEER of July 8th, 1910, is to be put into operation within the next few months. All the technical tests have been completed and the G.P.O. is at present ascertaining what is likely to be the immediate demand for the service among business houses. The scheme will enable letters, reports, or any kind of message to be automatically typewritten between any two offices in which the teleprinter machines are installed. The teleprinter is very much like an ordinary typewriter, and the same machine is used for both transmission and reception. The typist in one office simply types the material in whichever form it may be, and it is printed on the machine at the other end of the line, whilst at the same time a duplicate of the message is printed on the transmitting machine. Where the method is adopted it will largely put an end to letter writing in the ordinary way between one concern and another. A firm having private wires between the head office and the branches will be able to use the teleprinter by paying a rental based on distance, or alternatively people may become subscribers to the teleprinter exchange system, in which case the cost will be limited to the time the service is used. As the teleprinter works over any distance covered by the telephone, there is no reason why it should not be used between this country and the Continent. When the scheme is nationally adopted there will be a network of teleprinter exchanges all over the country, and subscribers will be put into rapid communication with customers or agents, irrespective of whether they are one mile or a thousand miles apart.

Financing the French Line.

IN our leading article on the new Cunard liner last week, when discussing the international competition in Transatlantic passenger traffic, we stated that the French Government, in its efforts to finance the French line and to forward the construction of the new super "Ile de France," was not finding its task a light one. That fact was confirmed by the vote in the French Chamber on Tuesday last, December 22nd, which sent back the Bill advocating further State support, to the Finance Committee, an adverse Government vote of 275 to 266 votes being recorded. The Finance Committee was immediately convoked. The Bill authorises a further loan of 300,000,000f., or £2,400,000 at par, and provides for an increase in the mail subsidy to 30,000,000f., or £240,000. In the discussion it was stated by Monsieur Bertrand, who presented the report of the Committee, that the alternative to further support was the bankruptcy of the French Line, which would have the gravest consequences. Opponents of the Bill contended that in addition to the £2,400,000 now suggested, the company would need a further £5,000,000. In defending the Bill, Monsieur de Chappedelaine, Minister of Mercantile Marine, stressed the importance of retaining France's share of the Atlantic traffic. If it were allowed to lapse there would, he contended, be a serious diminution in the number of North American visitors to France. The discussion revealed a variety of opinion concerning the completion of the super "Ile de France," and various speakers suggested that having in view the suspension of work on the new Cunarder, it might be advisable to hold back the completion of the French ship, at least until the intentions of other countries were known.

The Laws of Ship Resistance.

By G. S. BAKER.

No. VI. (*conclusion*).*

APPENDAGE AND WIND RESISTANCE.

In framing these notes the object has been to show how the resistance of various appendages arise, their relative proportions, and the extent to which this resistance may be varied by change in design. This has involved, in most cases, giving approximate formula for their resistance which *can* be used with reasonable accuracy to calculate appendage resistance. Such a calculation is never very satisfactory as the most important term in the formula—speed—is always an approximation. At the end of the notes average allowances are given, and in special cases these formulæ are guides as to whether any variation, and how much, should be made in these average figures. A fair indication of the variation of wind resistance for different superstructures is given, but a little judgment is always required in making an assessment in any particular case.

Shaft Casings or Bossings and Shaft Struts.—The bossings are really part of the propulsive mechanism of the ship, and more variation is likely to arise from their effect upon the propeller efficiency than from their own resistance. Consideration must always be given in the first place to this effect. Where the shaft leaves the ship, a casing or fashioning, tapered towards the after end must be worked around the shaft at this point, or there will be a definite break

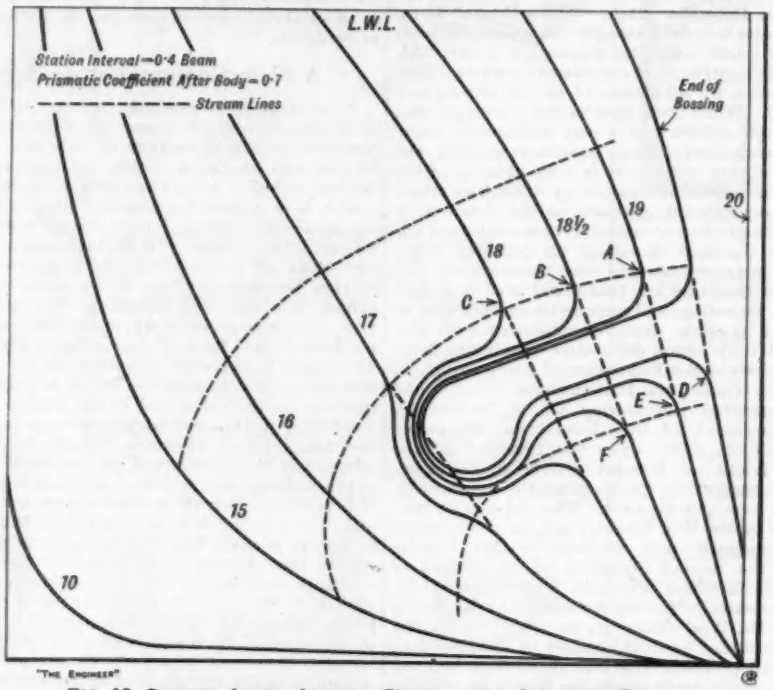


FIG. 16—STREAM LINES AROUND STERN, WITH ADJUSTED BOSSING

in the water flow and consequent eddy-making. If the shaft is to be supported on A brackets at its after end the above fashioning need only be quite short so far as resistance is concerned. In many cases in order to facilitate access to the shafting, this casing is worked right to the end of the shaft, the A brackets then being replaced by a spectacle frame casting which forms the after end of the bossing. With bare shafting supported on A brackets, water must necessarily flow obliquely across the shafts, and a slight amount of eddy-making take place. A bossing or webb will prevent this, but as a set off one has the additional skin friction of the web. With all such webs it is necessary to place them at such an angle that they cause minimum interference with the general flow of water past the ship. Model experiments have shown that in general the most resistful form of support for shafting is a web carried to about half the outboard length of the shaft, with an A bracket just in front of the propeller. The least resistful is an A bracket with only a very short tapered fairing piece where the shaft leaves the hull. Any outboard coupling on these shafts should be suitably shrouded by working an elliptical nose in front and filling behind with a conical tapered piece of small angle—about 10 deg.

The actual shape which a bossing should take can be determined by measuring the direction of the stream flow around the stern in the vicinity of the bossings. This is done by means of "flags" fixed to spindles which are passed squarely through the hull to the inside of the model. A graduated scale is fixed inside, and when the model is towed down the tank, the flags take up a definite position given by an indicator inside the hull. These positions are afterwards marked on the hull surface and lines are drawn on the model, which everywhere run parallel to the flag marks. This will give the flow of a layer some 18in. thick for ship, close to the hull, and the lines along which the shaft bossings join the hull should follow these streams. Such a set of lines is shown in Fig. 16. In the figure, the trace lines A B C and D E F passing through points on each section, where the bossing joins the frame lines, follow the general stream line flow as found without the bossing. The presence of the bossing and the action of the propeller will alter the flow a little, but the main body of water along the top and bottom of the bossings will reach the trailing edge with the *same* velocity and coalesce without eddy formation. If the lines A B C and D E F cut upwards and across the flow lines, it will mean that the bossings are restricting the inner upper layers, and expanding the corresponding layers beneath them. These layers would then reach the after end of the bossings with different velocities on upper and lower surfaces, an undesirable thing in itself. Such a change of angle increases the resistance, as shown for a particular model in Table XXII. At the same time it promotes an angular flow of the water into the screw disc, which affects the slip angle and efficiency by varying amounts at different radii, and in opposite directions with inward and outward turning screws. The increase of resistance is lowest and usually the screw efficiency highest, with bossings arranged to follow the streamline flow.

At the after end of the bossing the maximum slope of the casting to the general run of the top and bottom of the web should not *exceed* 15 deg. This is illustrated in Fig. 17. The fore edge of the propeller should in any case be kept well away from the line B in the figure at which the 15 deg. lines meet. If these rules are followed twin bossings will have a resistance little more than their estimated skin friction—taken on their own length—and varying from 2·0 per cent. on full to 4·0 per cent. on fine mercantile vessels, and 6 per cent. on express liner and cruiser forms. On

TABLE XXII.—*Effect of Angle of Bossing on Resistance of Model W. J. Luke's Tests with Twin-screw Model.*

Beam 58·5ft., draught 17·6ft., prismatic coefficient fore body 0·627, after body 0·719, spread of screws (centres) 19·6ft.

Angle of bossing to horizontal, degrees	0	22·5	45·0	67·5
Hull resistance with bossing / Hull resistance without bossing	1·10	1·04	1·03	1·05

NOTE.—With fuller vessels the angle for minimum resistance diminishes. Also with outward-turning screws the bossing should be a little nearer horizontal than the position for minimum resistance.

quaruple-screw ships the bossing resistance for ship should vary from 4·0 per cent. to 6·0 per cent. These percentages are for ship and *not* for model—on the latter they would be roughly twice the amounts given above. With a fairly full mercantile form doing 11·0 to 12·0 knots on 400ft. length the angle of the web to the horizontal in the body plan should be roughly 15·0 deg., at most 20·0 deg., with normal ship proportions. With finer forms having more V-shaped sections aft, or with cruiser sterns of moderate depth the angle of bossing usually increases up to 25·0 deg. For intermediate liners with quadruple screws placed on about the same level the angle of the wing screw bossings should be about 40·0 deg., and of the inner screw bossings about 25·0 deg. or a little less.

When A brackets and external propeller shafting are used the resistance can be taken either as a half to one per cent. less than that for solid webs, or be worked out in detail. The approximate resistance of a strut in sea water placed "fore and aft" as regards the stream flow is given by

$$\text{Resistance in pounds} = k\,S\,V_1^2 \quad . \quad . \quad (20)$$

S being the wetted surface of the strut in square feet both sides, V_1 the velocity in knots through the wake water, k has a value 0·012 for shape B, 0·036 for shape A, in Fig. 18.

The resistance of a rotating shaft inclined at a small angle to its direction of motion is not known exactly. When not rotating the resistance of such a shaft projecting from a ship's surface may be taken as

$$\text{Resistance in pounds} = 0{\cdot}2\,l\,d\,\sin\theta\,V_1^2 \quad . \quad (21)$$

where d is the diameter of the shaft in feet, l is its outboard length. θ, the angle at which the water is flowing across it, varies from 20 deg. to 10 deg. for full and fine ships respectively at its fore end to about 2 deg. at the propeller.

When the run is varied in fullness the two factors l and $\sin\theta$ tend each to cancel the variation of the other. Since neither V_1 nor θ is known very accurately for any ship, this method is never very reliable, but the details serve to show where loss occurs, and the effect of strut shape.

Rudder and Rudder Post, Twin-screw Ships.—There are two main types of rudder. The old navy type, plated on both sides, presenting to the water an unbroken surface, slightly convex in horizontal cross section. If balanced, it has no post in front of it. If unbalanced, the general practice is to bring the stock close up to the post, leaving practically no gap between them, so that for stream flow purposes the rudder and its post constitute one smooth surface, and with twin-screw ships forms a clean continuation of the hull. The addition of an unbalanced rudder of this type to a twin-screw model of prismatic coefficient 0·58 caused a reduction of 2·0 per cent. in resistance, despite the increased wetted surface due to the rudder. In a second twin-screw form with prismatic coefficient of run equal to 0·652, with length of run equal to three beams, there was no difference in the resistance with and without such a rudder.

The second type is the ordinary "plate" rudder consisting of a vertical stock with a considerable gap between it and the rudder post. Behind the stock comes a flat plate with three to six horizontal arms with large excrescences to secure it to the stock and

FIG. 17 Fore & Aft Section, Normal to Web, at After End of Bossing.

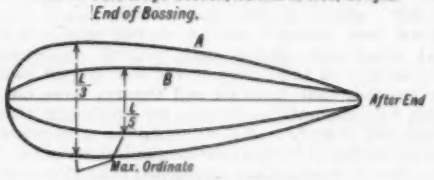


FIG. 18 Strut Sections.

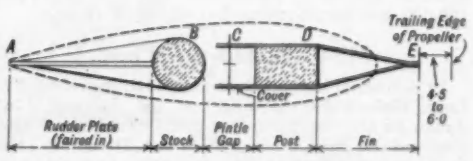


FIG. 19 Horizontal Section of Rudder, Rudder Post, & Fin. Single Screw Ship. The Dotted Line Shows an Alternative & Full Shape for Line A.B.C.D.E.

"THE ENGINEER"

carry the pintles. At the upper end of the stock is a large coupling. All of these abrupt features mean eddy making, amounting to 1 or 2 per cent. loss in a twin-screw ship of intermediate liner type. This can be reduced in a built ship by placing the coupling vertical and fore and aft, fairing over the bolts with cement, and covering the gap between stock and post with plating or filling it in as much as possible. In any new ship all these features should be streamlined.

In a single-screw ship the rudder and its post are placed in the slip stream of the propeller, and a plate rudder as above described then increases the resistance by some 3·0 per cent. to 4·0 per cent. Recently it has been shown that if a fin is worked on the middle line plane of the ship, filling the gap between the fore side of the post and the trailing edge of the propeller, it will increase the propeller efficiency and reduce the power for a given speed in a large variety of ships. This cannot be discussed here, it need only be said that to secure the best results with such an arrangement the fin, rudder post, stock and rudder should be arranged to form a complete and single streamline body with its fore edge about 4·5in. to 6·0in. aft of the plane of the trailing edge of the propeller. Fig. 19 shows the arrangement in outline. The actual shape of the line A B C D E is of no importance, and the same propulsive result would be obtained with the narrow as with fuller form in the figure. The position of the maximum ordinate, the

* No. V. appeared December 18th.

rudder stock and pintle axis within the outline can be varied quite materially without any effect upon the result. The gain from a complete adoption of the above treatment of the rudder, &c., compared with the results with the normal plate rudder, varies from 1 or 2 per cent. with a form already giving good results to 10 per cent. or 12 per cent. for a full form of poor performance.

In many shallow-draught vessels, destroyers, &c., the rudder projects through a rather flat-bottomed stern, has no bottom support, and no structure in front of it. This is called a "spade" rudder, and is usually plated with a fair smooth surface. The resistance in this case can be calculated from formula (21) for strut B of Fig. 19. Such a rudder of normal proportions would have a resistance varying from 1·0 to 1·5 per cent. the naked hull resistance.

Bilge Keels.—The direction of the streamline flow around the bilge can be determined by the method described in dealing with shaft bossings, and a bilge keel trace can then be put in following the stream flow. Experiments on a number of models have shown that along the parallel body such a trace will retain almost its usual position on the bilge turn, moving slightly out as it goes aft. Quite material changes in speed make very little difference to this trace, except in the entrance, where it is affected by the varying wave motion. For this reason it is never advisable to work a bilge keel very far into the entrance, if there is material wave motion at the service speed. It can, however, be carried some little way into the run if desired. As regards their resistance, it should be observed that the keels are in the frictional belt, and that the gliding velocity of the water past the keel at its base will therefore be approximately 0·5 V. If the depth of the bilge keel is equal to the thickness of the frictional belt, the gliding velocity on its outer edge will be 1·0 V. The thickness of the frictional belt is given by equation 3, page 534—Article No. I., November 20th—and at 100ft. and 300ft. from the stem, would be 0·9ft. and 1·7ft. respectively. If the bilge keel is kept within such limits, its head resistance is kept down without any detriment to its action in extinguishing rolling.

An estimate of the resistance of a bilge keel can be made from its frictional resistance assuming a mean velocity based on the above according to its depth; but it is simpler to reckon the area of the keels—both sides—as additional wetted surface of the ship, and to increase the skin friction in the same proportion. Lee has shown that in non-turbulent flow this exceeds the correct value, but with turbulent flow the same conclusion will not necessarily hold good.

Such an estimate assumes that the bilge keels are correctly placed in the stream flow. If placed obliquely across the flow, eddy resistance will be introduced, the approximate excess resistance being given by:

$$R \text{ in pounds} = k\,A\,\alpha^2\,V^2 \quad . \quad . \quad . \quad 22$$

where A is the area of one side of the two keels in square feet;
α is the angle of obliquity in degrees;
k has a value of 0·001 for all small angles;
V is the ship velocity in knots, this being taken since the outer edge of the keels on which the eddies are formed, is outside the frictional belt.

A pair of bilge keels of area 400 square feet at a mean angle of 2·5 deg. from the best position, at 20 knots, will require an effective horse-power of 64 additional to that due to friction.

Air Resistance of Above Water Hull and Superstructure.—It is impossible to obtain a measurement of this at sea, as any wind creates waves, and the effect of these upon the ship and its propellers cannot be separated from the air resistance. On the measured mile similar difficulties would occur, but it is rare for a trial to be made in a severe wind, and no one is prepared to take the precautions necessary for a definite result, on a matter rather remote from the object of the trial in the minds of the principal people concerned.

One difficulty in the measurement of this resistance on a model, is the very small size of many hull features when made to model scale. With the highest air tunnel speed available, the Reynolds number is far too low for any accuracy, unless the air is under a pressure of at least 10 atmospheres, and no variable density tunnel will take a ship model of even 6ft. total length. A partial solution of the difficulty has been tried by towing models of the superstructure through water. The theoretical laws of resistance are the same in air and water, and a 16ft. to 18ft. model can be towed at any angle to the "wind," as represented by the velocity and direction of tow. The Reynolds number which can be reached without creating waves is approximately $4·5 \times 10^6$. The tests were made with three different types of hull:

C, a tanker with "three island" structures above the upper deck and one funnel well aft.
I, intermediate steamer, three island structures, with the funnel on the centre one, which was fairly long.
L, an Atlantic liner, with short forecastle and well, long complete midship structure lined along both sides with double-tier boats.

The results were expressed as follows:—

Let B_1 be the area of main hull above water in square feet projected on a transverse plane.
B_2 be the area of the superstructure, funnel, &c., projected on a transverse plane.

The air resistance of the main hull per unit projected area, was considerably lower than that of the superstructure, the ratios being:

	Type of hull.		
	C.	I.	L.
Wind ahead	0·31	0·27	0·26
Wind astern	0·36	0·32	0·26

If the main hull is expressed in terms of "equivalent superstructure" area, the total projected area above water can be written as:

$(B_2 + 0·31\,B_1)$ for type C with wind ahead, &c.

Calling this area B, the wind resistance R, along the axis of the ship, is given by:

$$R = k\,B\,V^2 \text{ lb.} \quad . \quad . \quad . \quad . \quad . \quad (23)$$

where k is given in Fig. 20, and V is the *relative* wind speed in knots. The figure covers a wind from any direction within 50 deg. of ahead or astern. For example: If B_1 is 1500 square feet, B_2 is 2000 square feet, on a liner, and the *relative* wind speed V is 30 knots at 30 deg. from the bow, the k value in Fig. 20 is 0·0048 and ahead resistance

$$= 0·0048\,(2000 + 0·26 \times 1500)\,(30)^2 = 10{,}300 \text{ lb.}$$

In still air, the air resistance in loaded condition for the three types of ship tested, expressed as a percentage of the naked hull resistance at service speed, was 2·7, 2·7 and 2·1 respectively on C, I and L types.

Total Appendage, Superstructure and Weather Resistance.—In framing estimates for the power required for propulsion, it is not always possible and, in many cases, not necessary, to calculate the resist- of individual appendages, superstructure, &c. For many years at the William Froude tank an allowance varying from 10 to 12 per cent. has been made for these features for loaded ship, in fine weather, on the measured mile, i.e., in protected waters. For such vessels as cross-channel steamers, war vessels and river passenger steamers, having high superstructures, this allowance should be increased, up to 14 per cent. in a few cases. Similarly, with a vessel in ballast trim, a small increase in the allowance is required. These figures are based partly on model tests, and partly on the results of ship trial analysis of good forms with correctly placed bossings. Roughly, this percentage can be assumed to be made up as follows:—

TABLE XXIII.—*Standard Appendage Allowance for Measured Mile Conditions.*

Item.	Cargo and intermediate ships.		Fast passenger vessels.
	Single.	Twin.	
Bossings	0	2·5	4·0
Bilge keels	3	2·5	2·5
Rudder	4·5	2·0	1·5
Above water	2·5	3·0	2·0 to 4·0

In estimating for average weather at sea, an additional allowance must be made to take account of the resistance due to wind on the above water hull, and the loss arising from the action of waves on ship and propeller. Analysis of a number of ship logs shows that this may be taken as approximately 20 per cent. for the North Atlantic, varying down to 15 per cent. for the South Atlantic and Pacific, i.e., the horse-power required at the service speed will be that obtained on the measured mile at this speed plus the above additions.

These allowances do not cover *very* rough weather, during which the risk of damage to the ship and engines necessitates lower engine revolutions. At this lower speed, although the rough weather effect is high, the *total* power used is actually below that of the service speed with normal allowances.

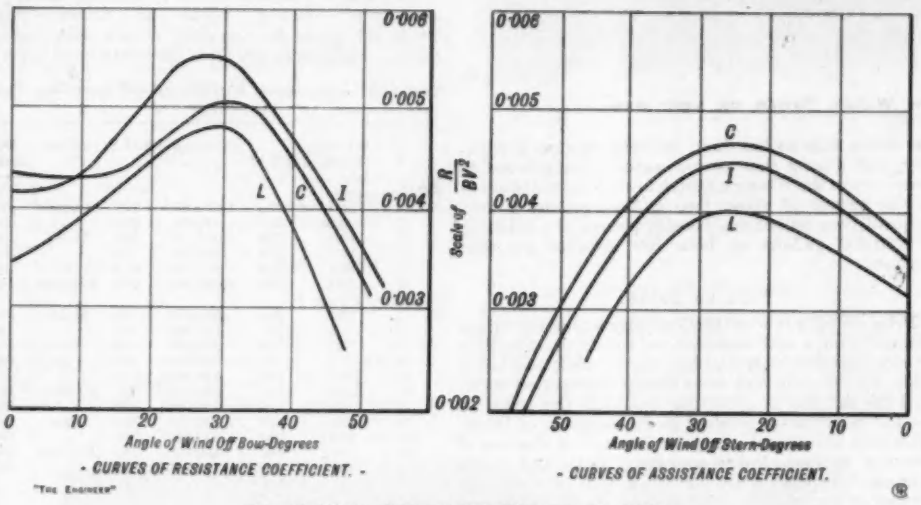


FIG. 20—WIND RESISTANCE FORCES ON HULL

Values of $\frac{R}{B\,V^2}$ for Three Types of Ship-Cargo, Intermediate and Liner.

Shanghai Waterworks Extensions.

By H. STRINGER, B.A. A.M. Inst. C.E., M.I. Mech. E., Deputy Engineer-in-Chief.

No. II. (*conclusion*).*

RAPID FILTERS (*continued*).

As the efficiency of operation depends almost entirely on the arrangements for backwashing, the following details as to the combined underdrainage and backwash system are given. Each filter has an area of 1400 square feet, and is divided into two parts, 41ft. by 17ft. 2in., fed by a central duct, 3ft. 6in. wide, with a clear water duct underneath, 3ft. 6in. by 2ft. 6in. The design of the underdrainage and backwash system is what is known as the "Illinois Standard."

There are seven wash water troughs per filter. They are fixed at 5ft. 10in. centres and 6ft. 6in. above the filter floor level with a free-board from sand level to lip of 2ft. The troughs are constructed in reinforced concrete 2in. in thickness, with a semi-circular bottom of 7in. radius inside, with a rectangular section 12in. deep by 14in. wide above. They are constructed with a fall of 3in. in their length of 17ft. 2in., to the central duct. The sizes of these troughs are based on an expansion of 45 per cent. with the sand selected. The under-drainage and washing system consists of forty-eight laterals per half filter fixed 10in. apart. They are of cast iron, 4in. in diameter, with thirty-five $\frac{7}{16}$in. holes per lateral at 6in. centres. Experiments with an under-drainage system in porous concrete proved a failure in practice. The system was designed on the following basis:—Total area of strainer holes, 0·2 per cent. of filter area; laterals three times total area of strainer holes; manifold or duct 1½ total area of strainer holes.

Venturi-type rate-controllers and loss of head gauges are employed for the regulation of the filters.

As regards rapid filter sand, the ordinary slow sand filter yields 44 per cent. of a sand within the required limits, its effective size being 0·44 mm. in diameter, the size of sand which gave 60 per cent. finer than this size being 0·80 its uniformity coefficient thus being 1·82.

Sand of suitable quality is then obtained by rejecting that which was retained on a sieve with 18 meshes—1·15 mm.—to the inch and keeping that which was retained on a 40 mesh to the inch screen—0·43 mm. The coarse sand retained on the 18-mesh sieve is then re-screened through a 10-mesh sieve—2·10 mm.—and that which is retained rejected, while that which passes but is retained on the 18-mesh sieve is kept. After screening the filter is filled with 2ft. 3in. of the first sand and 3in. of the second, the complete filtering medium being as below:—

	Mesh.	Quantity for one filter. Cubic feet.
Sand, 2ft. 3in.	18–40	3150
3in.	10–18	350
Gravel, $\frac{1}{16}$in.–$\frac{3}{16}$in.	3in.	350
$\frac{3}{16}$in.–$\frac{1}{4}$in.	3in.	350
$\frac{1}{4}$in.–$\frac{1}{2}$in.	3in.	350
$\frac{1}{2}$in.–1in.	4in.	467
2½in.–1in.	5in.	583

* No. I. appeared December 18th.

The details of the piping which feeds and drains the filters are as below: —

Influents for settled water	20in. in diameter
Sewer for wash water ..	36in. with 30in. tees to filters
Wash water pipe	30in. with 24in. tees to filters and 18in. to clear water chlorinating chamber

This is designed to supply 27,400 gallons per minute with a head of 40ft. from a wash water tower of 165,000 gallons capacity, 90ft. by 30ft. by 10ft., giving ample water for a six-minute wash.

All piping passing through water-bearing walls is fitted with puddle flanges and the concrete round all such castings is specified as 1 : 1 : 2. Fig. 12 shows the general appearance of a rapid filter battery, with wash-water tower to the left. Fig. 13 shows the pipe gallery and system of piping with raw water mains on

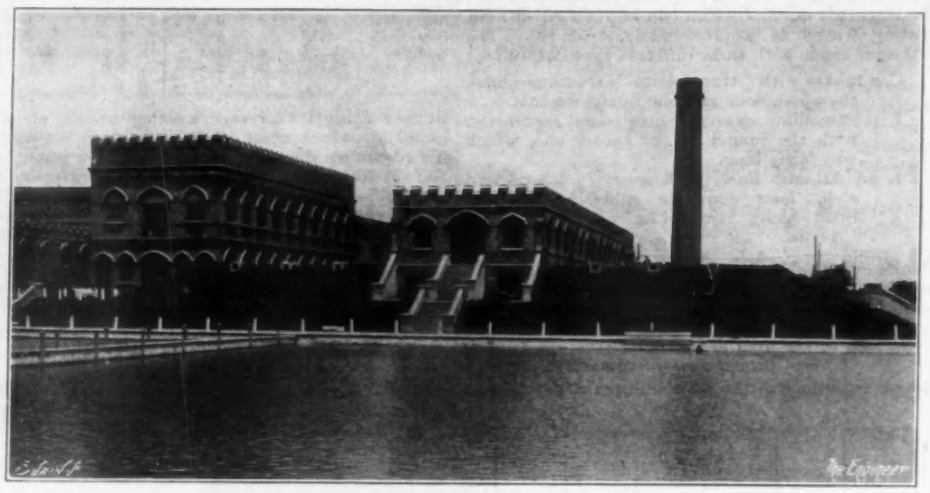


FIG. 12—RAPID FILTER BATTERY—WASH WATER TOWER ON LEFT SIDE

top, sewer in the middle, wash pipe, clear water and rate controllers on the floor.

In operation, these filters have been uniformly satisfactory. The rate of working is 100 gallons per square foot per hour, and the filters are washed at a 6ft. loss of head, but always once in twenty-four hours, the percentage wash water used averaging 3·62 for the year 1930. The bacterial reduction from river to filter effluent is 99·51 per cent., and after chlorination at the filters 99·99 per cent. Pre-chlorination was introduced in the summer of 1929, and it has reduced the bacterial load on the filters by 90 per cent. with consequent further improvement in the effluent. The average dose used is 0·5 part per million. Chlorination is also used on all suctions of the main pumps, the average dose being 0·2 part per million.

GENERAL.

This completes the description of the major extensions, but much additional work has been carried out on engine-house extension and engine foundations. As regards general principles influencing local design, the following factors are perhaps worthy of notice.

B. coli are present in the local soil, and every precaution has to be taken against leakage in water-bearing structures. Owing to the possibility of deeper local excavation, and to the fact that the local mud is known to flow under certain conditions of pressure at angles as low as 10 deg., the principle of rafting which prevailed prior to 1925 has been abandoned, and all structures are now piled, an adhesion of 300 lb. per square foot for squared, and 350 lb. for tapered piles being adopted, the usual impact formulæ being inapplicable. Loads without settlement up to 430 lb. per square foot have been applied.

Except in the case of engines, piling takes the balance of load over 1000 lb. per square foot; in the case of engines, the whole load is so taken. For a tunnel for three 40in. mains under the main road which divides the company's property, the soil load was limited to 600 lb. per square foot, as settlement in that area would have been a serious matter.

PUMPING MACHINERY.

Shanghai's water is an entirely pumped supply. Table I. below shows the monthly consumption and

TABLE I.—*Monthly Consumption.*

Month.	1930.		1929.	
	Total monthly, gallons.	Daily average, gallons.	Total monthly, gallons.	Daily average, gallons.
January ..	1,061,158,580	34,230,922	950,198,978	30,651,580
February ..	887,920,778	31,711,456	860,455,967	30,730,570
March ..	1,055,072,907	34,034,610	966,547,040	31,178,936
April	1,046,525,215	34,884,174	979,797,266	32,659,908
May	1,167,115,376	37,648,883	1,063,467,570	34,305,405
June ..	1,267,086,853	42,236,228	1,144,506,265	38,150,209
July	1,483,967,204	47,869,910	1,326,979,333	42,805,785
August ..	1,530,683,681	49,376,893	1,395,021,857	45,000,705
September	1,335,600,177	44,520,005	1,210,744,431	40,358,148
October ..	1,211,043,095	39,065,906	1,149,616,529	37,084,404
November	1,138,741,805	37,958,060	1,060,046,008	35,334,867
December	1,135,044,771	36,614,347	1,040,343,233	33,559,459

daily average for the years 1930 and 1929. Maximum daily demand usually occurs in August and was 53,496,807 and 50,796,404 gallons for the years considered.

In common with all waterworks undertakings, the company has to deal with a very variable daily load. Thus the ratio of the average to the maximum hourly demand is approximately 1·7, but the engine capacity must be capable of meeting the maximum demand, and the mains must be of similar capacity. A further handicap is that the maximum hour demand increases at a greater rate than the average day demand, with, consequently, more rapid decrease in the load factors of the older units, the natural policy being to run the newer and more economical units at high load factor.

At night, for a period of about six hours, demand on the mains falls to less than half the maximum capacity, and during that period water is transferred to reservoirs in the Western District—6·5 miles distant—to the extent of about two million gallons a day. Motor-driven centrifugal booster pumps of a capacity of 780,000 gallons an hour are installed for that purpose.

TYPE OF DRIVE.

Prior to 1929 it was the Company's practice to use plunger pumps and steam drive, which was found to be economical at high load factors, the peak load being taken by the older and more highly depreciated units. In 1929 the rise in operating cost and the onset of the fall in exchange resulted in the adoption of Diesel drive and centrifugal pumps on account of absence of standby charges, lower operating costs, and much decreased capital cost. Further fall in exchange compelled the adoption of the electric drive on account of still lower capital cost.[1] The increasingly important factor of obsolescence, in view of possible future improvements in design, was also not without its weight in the adoption of this policy.

Table II. gives all the necessary details relating to the main pumps, and with regard to operation it should be stated that in 1930 14,319,960,442 gallons were pumped against an average head of 130ft. at a coal[2] consumption of 1921 lb. per million gallons.

All these pumps, except Nos. 12 and 13, are of the steam-driven plunger type. These steam units are all of the compound type with the exception of Nos. 9 and 11, which are triple-expansion, the first being a horizontal double-acting pump and the last a vertical single-acting set.

TABLE II.—*Description of Main Pumping Engines.*

Main pump No.	Date installed.	Load factor, 1930, %	Steam per W.H.P. per hour, lb.	W.H.P.	Capacity gallons per hour,	Average day water pumped, 24th April 1930, M.G.
Station No. 1—						
3	1907 (rebuilt)	9·01	19·30	167·2	260,000	2·236
4	1903	0·19	20·80	161·4	268,000	—
5	1911	13·64	18·40	224·0	316,000	3·404
10	1927	46·31	14·70	304·5	400,000	7·765
Total						13·405
Station No. 2—						
6	1919	59·09	14·90	252·0	384,000	5·449
7	1921	47·23	16·19	213·0	295,000	4·389
8	1921	1·17	26·80	295·0	368,000	1·066
*9	1926	53·16	14·70	442·9	600,000	—
Total						10·904
Station No. 3—						
11	1928	77·26	10·50	560·0	600,000	14·878
*12	1930	15·69	2-cycle Diesel	560·0	600,000	—
*13	1930	82·55	Electric	650·0	660,000	—
Total						14·878
Grand total						39·187

Average load factor, 41·71 per cent.

* No. 9 engine under repair; Nos. 12 and 13 were only erected in June.

Fig. 14, p. 671, and Fig. 16, p. 678, show the three latest units for steam, Diesel, and electric drive.

As regards primary—river to settling tanks—and secondary — settling tanks to filters — pumps, Table III. gives the necessary details with regard to them. The pumps are all of the centrifugal type.

TABLE III.—*Description of Primary and Secondary Pumps: Centrifugal Type.*

	Working heads.	R.P.M.	Output g.p.h.	B.H.P.	Drive.	Date installed.
Primary pumps:						
No. 14	30ft.	290	1,250,000	300	Electric	1919
15	30ft.	290	1,250,000	300	,,	1919
17	19ft.	260	1,000,000	190	Diesel	1926
20	19ft.	250	500,000	100	,,	1930
21	19ft.	250	500,000	100	,,	1930
22	19ft.	428	1,000,000	175	Electric	1931
Secondary Pumps:						
No. 6	32ft.	220	200,000	90	Steam	1902
7	32ft.	225	400,000	90	,,	1906
9	33ft.	170	200,000	85	Gas	1911
10	33ft.	160	200,000	85	,,	1911
12	30ft.	170	450,000	120	,,	1919
13	30ft.	160	450,000	120	Electric	1919
16	30ft.	175	450,000	120	,,	1923
18	26ft.	260	1,000,000	190	Diesel	1927
19	26ft.	325	1,000,000	180	,,	1929
23	33ft.	480	450,000	120	Electric	1931
24	33ft.	480	450,000	120	,,	1931

It will be observed that there are four types of drive. Policy as regards new orders has crystallised into the adoption of half electric and half Diesel for power purposes, as no waterworks could ever be dependent on one source of power only.

The type of Diesel engine adopted was, in the first place, the four-cycle air injection, but though experience with these engines has been entirely satisfactory, lower capital costs have led to the experimental adoption of the solid injection two-cycle engine in the latest secondary unit. The later electric motors are of the auto-synchronous type, owing to their capacity for power factor correction.

The suction gas engine was adopted at a time when anthracite was cheap and easily obtainable, but civil war and difficulties of operation in times of trouble

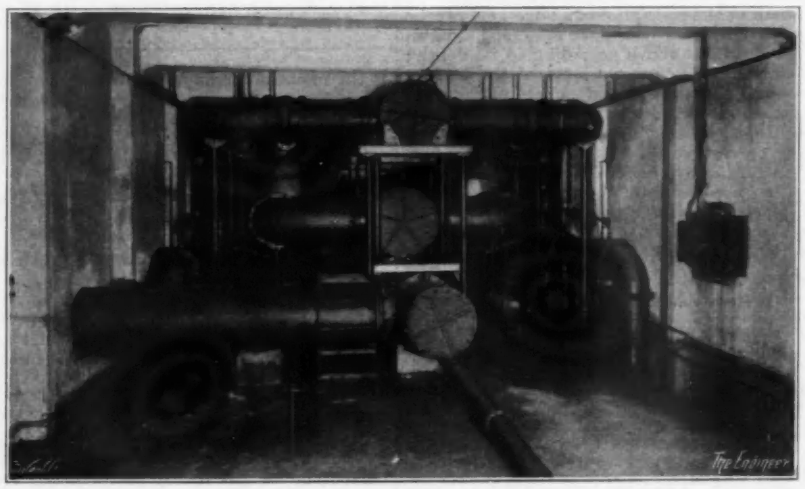


FIG. 13—RAPID FILTER PIPE GALLERY

[1] Power is purchased by the company at an average cost per kilowatt-hour, 65 per cent. load factor, of Tls. 0·01½ (G$0·006 or ¼d.); maximum demand charge Tls. 2·60 (G$1·08 or 4s. 5d.) per kilowatt. Power factor correction made.

[2] Calorific value of coal, 11,600 B.Th.U. per lb.

have led to the choice of an alternative electric drive for two of these pumps and the placing of the balance permanently in reserve. The two remaining steam units are only run occasionally.

Figs. 16 and 17, page 678, show the two types of oil engine drive.

MEASUREMENT OF PUMP OUTPUT.

In the case of centrifugal low-lift pumps measurement of output is made by Venturi meters of local design, pitometers, and imported Venturi meters being used for the main centrifugal pumps. An allowance of 2 per cent. is made for pump slip.

BOILERS.

Prior to 1927 all the boilers installed were of the Lancashire type, three being for pressures of 100 lb. and five for 150 lb. The low-pressure boilers have been fitted with improved grates and the 150 lb. boilers have automatic stokers of the underfeed type with forced draught. Experiments are now being made with a Hodgkinson's coking stoker working with natural draught The steaming capacity of these boilers is 7000 lb. per hour.

In 1927 a Babcock and Wilcox water-tube boiler was adopted to supply power to the last steam unit—No. 11. The pressure is 250 lb. and superheat 190 deg. Two boilers were installed, one of 13,000 lb. capacity capable of dealing with two engines similar to No. 11, and one of 8000 lb. capacity. In order to utilise the excess boiler power thus provided, and to work these boilers to full capacity, a by-pass steam main with desuperheater has been installed to serve the engines normally dealt with by the 150 lb. boilers. This arrangement will eventually reduce steam demand on these rather inefficient units to one boiler, which, as stated above, is being fitted with a new stoker.

The average evaporation from the boilers was, in 1930 :—

Pressure.	Superheat.	Average actual evaporation.	Feed temperature.	Economiser.	Boiler efficiency.
Lb.	Deg.		Deg. Fah.	Deg. Fah.	Per cent
100	100	5·32	219	83·5	45·6
150	100	5·56	277	125	45·?
250	136	6·72	186	114	60·

CO_2 recorders and flue gas temperature recorders are fitted in all boiler-houses and indicate good working results. Scaling troubles have only become serious with the high-powered boilers, and a boiler compound to rectify it is being tried.

BORINGS.

Sub-artesian water of a sterile nature is available in the Shanghai area, and though operating expenses are high, capital expenditure is small if the well is in a good strata. The Company has made two experiments in deep well borings of 6in. and 8in. diameter, using compressed air for pumping purposes. The first draws water from 750ft. and the second from 380ft. The water produced is of excellent quality, but the output tends to decrease rapidly as far as the Company's experience goes, and, owing to the necessity of fine screening, the well output is not high. The design of a suitable screen to exclude fine sand is the local problem as regards borings, and the company is experimenting in this connection. It may be mentioned that a further 12in. boring had to be abandoned owing to failure of the screen by cutting of the wire mesh by fine sand.

COSTS.

Pumping costs per million gallons in the three stages of pumping were as below for the year 1930 :—

TABLE IV.

	Pumpage, gallons.	Cost per million. £ s. d.	Cost per million. G$.	Cost per million. Tls.	Heads.
Primary ..	14,599,525,625	0 4 10½	1·20	2·89	19ft.
Secondary	12,967,298,500	0 5 3½	1·29	3·13	26ft.
Main	14,319,960,442	1 4 7½	6·00	14·49	130ft.

CAPITAL EXPENDITURE.

As regards capital expenditure in the period 1926–1930, some 3 million taels (£254,687, or G $ 1,244,813) for a rise in maximum hourly demand of approximately 1 million gallons, were expended, implying an annual capital expenditure of Tls. 600,000 (£50,937, or G $ 248,963) to keep pace with increase in water demand.

DISTRIBUTION.

The mileage of mains at the end of 1930 was 171·01. The main-laying programme for each year is fixed by the probable maximum demand checked by pitometer surveys made every two years. As regards pipes, all larger mains are now in steel, unlined, but protected by wrapping, a minimum cover of 3ft. being provided everywhere. In common with other waterworks undertakings, increased vibration caused by heavy motor traffic is having its usual effects. Thus leaks per mile of main increased from 3·20 in 1929 to 4·29 in 1930.

Owing to the abnormal increase in *per capita* consumption, the question of general metering is under consideration, but there are serious domestic problems to be faced in its adoption. At present all industrial supply is metered, and local conditions demand a wet dial meter wherever possible. The types in use are semi-positive to 1½in., inferential up to 3in., and Helix type with dry dial over this.

Finally, it should be said that extensions have gone hand-in-hand with improvements in the working conditions of the company's employees, of whom there are about 900. Men necessary for the operation of the plant work an 8-hour shift, and casual employees a 9-hour day. Careful statistics are kept of the cost of living and increased pay is granted on this score alone, apart from rises due to merited promotion. Quarters are provided for employees at rents far below those prevailing locally, and the education of children of employees is given free, with suitable facilities for recreation.

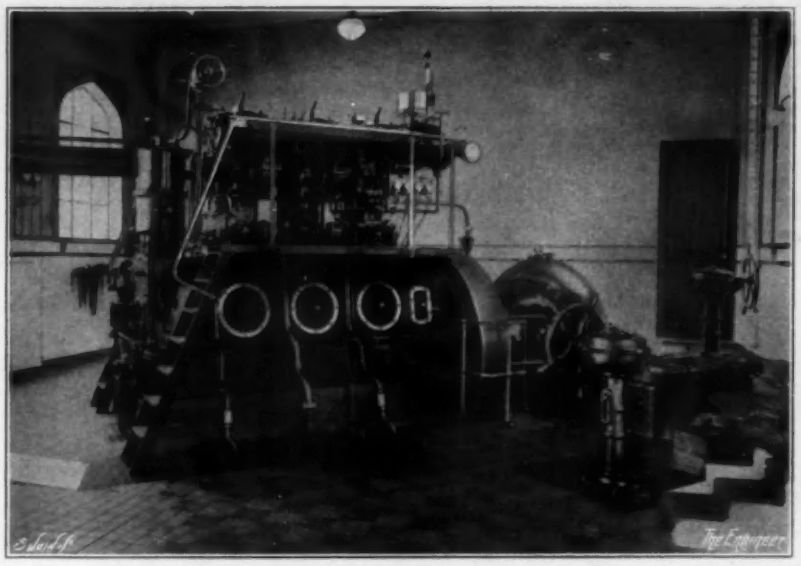


FIG. 15—FOUR-CYCLE OIL ENGINE AND LOW-LIFT PUMP

FIG. 14—TRIPLE EXPANSION SINGLE-ACTING STEAM PUMP

CONCLUSION.

All the works referred to in the foregoing have been carried out to the design, and under the direction, of Mr. C. D. Pearson, M. Inst. C.E., M.I. Mech. E., the engineer-in-chief and manager of the Shanghai Waterworks Company, Ltd., to whom the author is indebted for permission to make use of the above information.

The Manufacture and Use of Steel Railway Sleepers.*

By R. CARPMAEL, M.I. Mech. E.

(*Concluded from page 647.*)

The "G K N" Composite Sleeper: Guest, Keen and Nettlefolds' Type.—This type of sleeper is somewhat extensively used in this country and in India. British railway companies had in service at the end of last year about 120 miles of bull-head track laid with these sleepers, and foreign railway companies, including those in India, about 66 miles of flat-bottomed track. The first trials in this country were made in 1928—see Fig. 9—and after various modifications as a result of these trials, the sleeper has taken the form shown in Fig. 10.

This sleeper has on the whole given excellent results in service after the new ballast bed has settled down and consolidated. The track so formed maintains its line and level on curved sections as well as on straight in a satisfactory manner.

The Rolled Steel Chair Welded to Sleeper: Dorman, Long Type.—Although various designs had been put forward, it was not until the latter part of 1930 that a sleeper of this type, sufficiently reliable to justify actual service tests, was put on the market at an economical cost. Experimental lengths are under observation by each of the railway groups, particular attention being given to the maintenance of correct gauge of the track and to the reliability of the welding, the efficiency of which depends to such a great extent on the human element. Selected welds undoubtedly pass high and satisfactory tests, but in railway service, not only the selected, but the general, must be perfect. The sleeper is illustrated in Fig. 11.

The Sandberg Type.—In this type of sleeper the necessary lateral support for the bull-head rails is given by means

* The Institution of Mechanical Engineers.

of lugs or jaws pressed up from the top plate of the sleeper, which is ribbed to give the necessary rigidity. The rail seats consist of loose steel plates, shaped to the requisite "tilt," the whole—that is to say, rail and plate—being held firmly in position by the spring of the jaws acting through specially shaped keys. Following the laying in 1918 of a trial length on the former London and South-Western Railway—Fig. 12—considerable lengths are now in service on the Southern Railway, and experimental lengths are under observation in service on the other railway systems—Fig. 13.

This type of sleeper calls for particular care in the fit and drive of the keys and attention to "creep," which is greater than that with chaired road owing to the reduced width of lateral grip of the rail in the chair jaw. It has on the whole given excellent results in service after consolidation of the ballast bed.

The Ebbw Vale Type.—This is a pressed-up type of sleeper, in which the whole of the chair supports are formed during the manufacture of the sleeper, which is complete

Several such devices are in the experimental stage, and do merit serious attention.

In their recently published report, the Automatic Train Control Committee recommended the use of a fixed track ramp and locomotive plunger for providing the dual "warning" and "clear" effect at distant signals, a system which has for many years been in use on certain portions of the Great Western Railway. Although such ramps have not at present been fixed on steel sleepers, no serious difficulty need be experienced in doing so.

Other devices depend for their operation either on some form of "trip" gear moving with the signal arm or on the effect of light on the metal selenium. One such system, the "Radiovisor," provides for the use of eight electric lamps in the track, which, with other delicate and somewhat complicated apparatus on the locomotive, appear to be unsuitable for use under all conditions, particularly in severe winter weather.

Crossings.—Although in Germany, if not elsewhere, a certain limited use is made of steel sleepers for crossing

curved. The sleepers used on each of these two sections were 8ft. long.

At Swindon a specially prepared short section of the main line over which very high speeds are commonly run, was laid with equal lengths of 8ft. and 8ft. 6in. steel sleepers, and 8ft. 6in. standard timber sleepers.

As a result of these trials, it was decided to adopt the 8ft. 6in. sleeper as the standard, and all subsequent orders were for steel sleepers of this length.

Some doubt was felt at first as to the method to be adopted to ensure that the sleepers would be adequately filled with ballast before the passage of traffic. German railway engineers, with many years' experience behind them, prepare moulds of ballast to the contour of the sleepers. These moulds are formed by means of hollow "packing forms or gauges" resting on rails supported on adjustable pedestals and temporarily fixed in position, and at heights appropriate to the class of new track to be used. After being filled with ballast the frames are lifted off, the sleepers placed on the mounds so formed, and

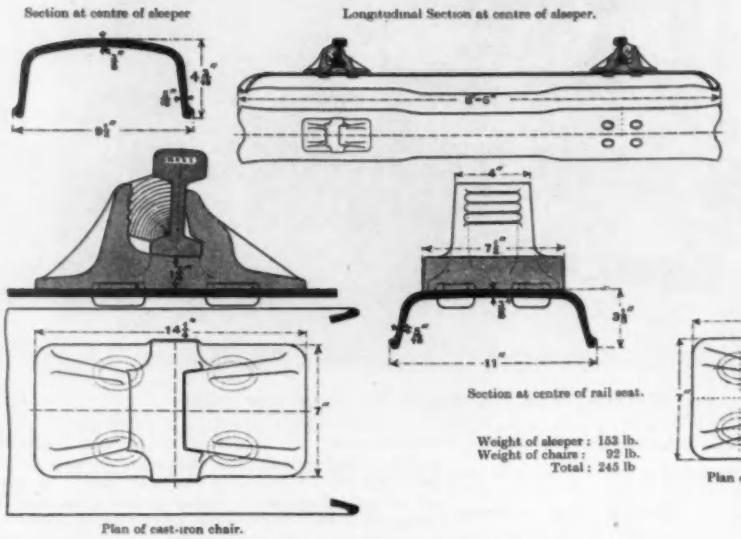

Section at centre of sleeper
Longitudinal Section at centre of sleeper.
Section at centre of rail seat.
Weight of sleeper: 153 lb.
Weight of chairs: 92 lb.
Total: 245 lb
Plan of cast-iron chair.
"THE ENGINEER"

FIG. 9.—*"G K N" Composite Type (First pattern used on G.W.R.).*

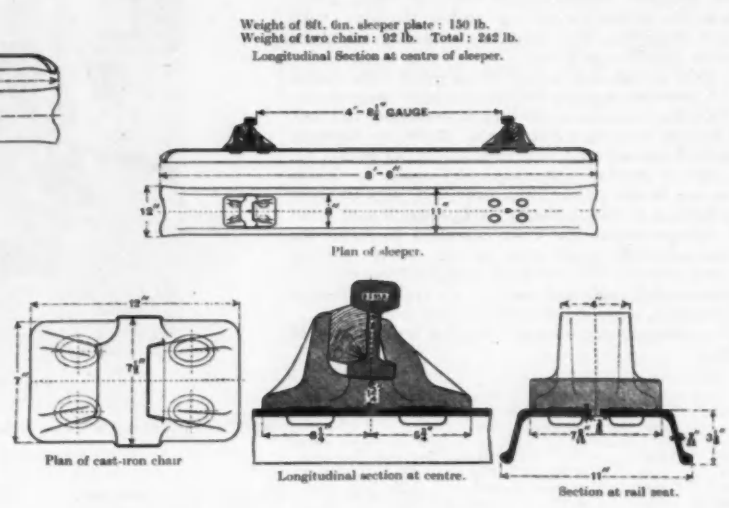

Weight of 8ft. 6in. sleeper plate: 150 lb.
Weight of two chairs: 92 lb. Total: 242 lb.
Longitudinal Section at centre of sleeper.
4'-8½" GAUGE
8'-6"
Plan of sleeper.
Plan of cast-iron chair
Longitudinal section at centre.
Section at rail seat.
SWAIN SC

FIG. 10.—*"G K N" Composite Type (1931 pattern for trunk lines of G.W.R.).*

in itself. Such a sleeper, having no loose parts, should, provided that accuracy of tilt and gauge be assured, stand up well to the practical tests which some of the companies have in hand. The sleeper is illustrated in Fig. 14.

The Workington Type: United Steel Companies.—This interesting example of a practical design of steel sleeper, of which a trial length has been in service for some twelve months, provides additional lateral support to the welded joint by a "dishing" in the sleeper plate. The rail seat in the rolled chair is formed to give the necessary "tilt" to the rail, and the chair jaws are strengthened by wings which rest upon and are electrically welded to pads pressed up from the trough of the sleeper. It is illustrated in Fig. 15.

There are practically no data available relating to the life of steel sleepers under the present conditions obtaining on British railways. The life of such sleepers in countries where the climate is not subject to the changes of humidity and temperature which prevail in our own, is no indication of their life in this country.

The introduction of innovations in the railway service presents difficulties foreign to those in most other services in that experimental work can only be undertaken in such a way that the safety of the travelling public is not imperilled. An added difficulty in the case of the railway service is the duration of time which must necessarily elapse before such an introduction can be described as economically successful. Whether the steel sleeper has an economic value comparable with that of the timber sleeper cannot therefore be stated definitely for some years.

With the object of obtaining data as full as possible under all conditions, steel sleepers have been laid on the Great Western Railway in various localities subject to as great a variation as possible in class, speed and density of traffic, gradient and alignment of track, nature of formation, and composition of ballast. Among these trials, of particular interest are those in the humid atmosphere of the South Wales Valleys, where lengths of steel sleepers have been laid with slag ballast—a local product—on severe gradients and sharp curvatures.

Should it be found that the life of these sleepers is unduly reduced owing to corrosion set up by the deleterious action of sulphur, &c., in the slag ballast, the use of steel sleepers would be abandoned in such areas, since it would obviously be uneconomical to transport stone ballast into a slag area, and *vice versâ*, unless the steel manufacturers produced at an economic price an alloy steel impervious to such action.

Electrical Insulation.—Assuming that the result of the various trials now being made on home railways is successful from the view-point of the permanent way engineer—from his own experience the author has no doubt that such a degree of success will be obtained—there still remains one great difficulty which at present entirely prohibits the use of steel sleepers on certain sections of track. It is the problem of insulation on electrified and track-circuited sections, a problem which has already more than once caused some little difficulty in locating trial lengths.

Several methods of insulation have been thought out, but none appear to have practical value, apart from the question of cost, which in itself would appear to rule out of the market the insulated steel sleeper.

Unless some economically efficient insulation can be devised, this limitation to the use of steel for sleepers can only be overcome by a modification of the signalling system to afford, by means independent of track electrification, control similar to that now given by track circuiting.

work, these do not appear to be very successful, partly owing to the lack of strength of the longer members, partly to difficulty of efficient packing, on account of the close spacing, and partly to difficulties of alignment, except with standard junctions of a simple character.

The weakness difficulty has been overcome to an extent in Germany by filling the sleepers with hardwood timbers or with concrete reinforced with stout wire netting. Such a filling, resulting in a solid sleeper, does remove the ballast packing difficulty, but it would not appear to be either a really practical or economical solution of the difficulty.

In the case of the composite, chaired type, the difficulty of correct alignment would appear to preclude the use of steel sleepers for crossing work.

Steel Sleepers on the Great Western Railway.—Of the

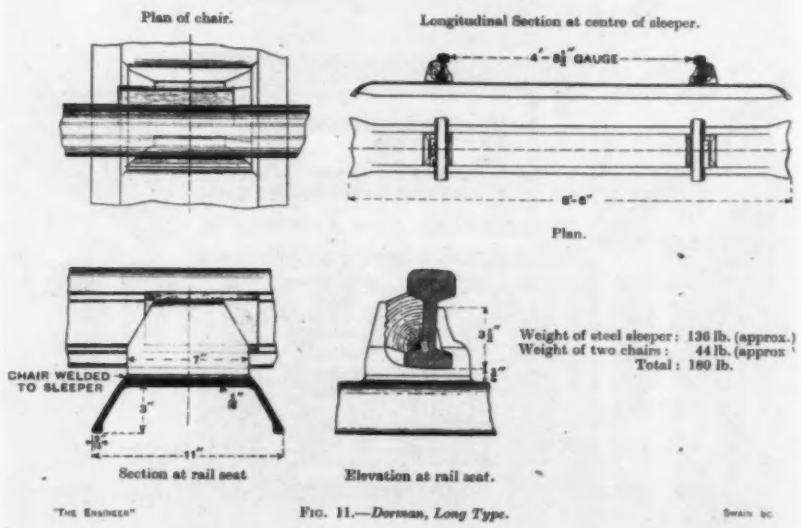


FIG. 11.—*Dorman, Long Type.*

total of 14,275 tons of steel sleepers in service on the Great Western Railway, 14,010 tons are of the "G K N" type. These sleepers only differ from the G.W.R. standard timber sleeper in that the chair, instead of being secured thereto by means of two bolts, is cast on and held in position by means of four cast iron snugs, which are really rivets.

The first trial length of about half a mile was laid down between Risca and Cross Keys, and has been in service for two years. This section of line is formed of comparatively sharp curves, some as sharp as 11 chains radius, and carries some 40,000 tons of traffic—principally coal—every twenty-four hours. In this instance, the locally produced slag ballast was used with the object of ascertaining the corrosive action of sulphur, &c., in the slag.

The second length, also about half a mile, was laid near Twyford on the down relief line over which speeds of 60 miles an hour are commonly run. The section is slightly

lightly tapped. This method is obviously cumbersome and slow, the relaying by eighty-seven men in eight hours of a length of 820 lineal yards being accounted a good performance. As relaying is carried out at double this rate in this country, other methods were obviously called for.

With the early trial lengths the following methods were adopted:—

(*a*) Forming ballast mounds by hand.

(*b*) Filling the inverted sleepers with ballast and tilting them over to the correct position.

(*c*) Levelling the old ballast, after addition of new ballast if required, placing the sleepers in correct position, and rolling them in with a locomotive.

German engineers claim that by the preformation of mounds in exact positions, high-speed traffic can be passed over the relaid track without further packing. The author would not be prepared to do this with our heavier axle loads and greater speeds. Of the three methods, it was found that the two first were not sufficiently exact and were too slow. The third method, that of rolling in the sleepers, appears to be the most generally suitable.

So far as the author's experience goes, steel sleepers require considerably more attention immediately after relaying than do wooden sleepers, but when the new ballast bed becomes firmly consolidated, the steel sleeper track holds the line and level with less maintenance. It should be appreciated that when changing from timber to steel, considerable addition to the ballast bed is required to maintain rail level, owing to reduction in depth of the sleeper and to the necessity for filling the sleepers.

It is the author's practice to adjust—that is to say,

slack back—oil, and retighten chair bolts in timber sleepers at least once a year. The use of sleepers with no such adjustable fastenings produces an annual maintenance saving on this account of about £5 per track mile.

Costs.—Apart from the initial increase in ballast used, the cost of laying-in steel sleeper track is not greatly different from that for timber track. When reproducing steel track this initial charge would not be repeated.

Maintenance costs are slightly lower for the steel track owing mainly to the absence of sleeper bolts, to which reference has just been made. Time alone will show whether the reproduction costs, with allowances for scrap values, will be fairly comparable or not.

The welded-on chair presents certain difficulties, both in the economical production of a rolled chair, which must, of necessity, be used with a welded joint, and of the joint itself, which must be a thoroughly reliable one.

That the railway companies have confidence in the practical value and the ultimate success of the steel sleeper is indicated by the extensive use of the various types to which reference has been made.

Experience has proved that heavy traffic, at speeds approaching, if not exceeding, 80 miles an hour, may safely be run on tracks of these descriptions, and provided that steel sleepers have an ultimate life economically comparable with that of timber, our home industries and our national prosperity should in the future be greatly benefited by their extended use.

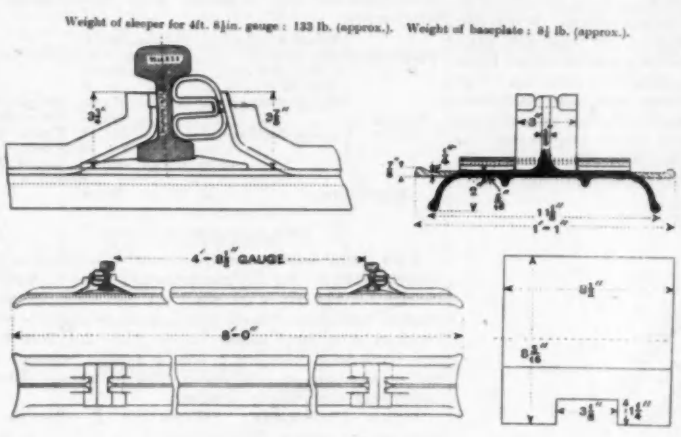


FIG. 12.—*Sandberg Type (First pattern used on Southern Railway).*

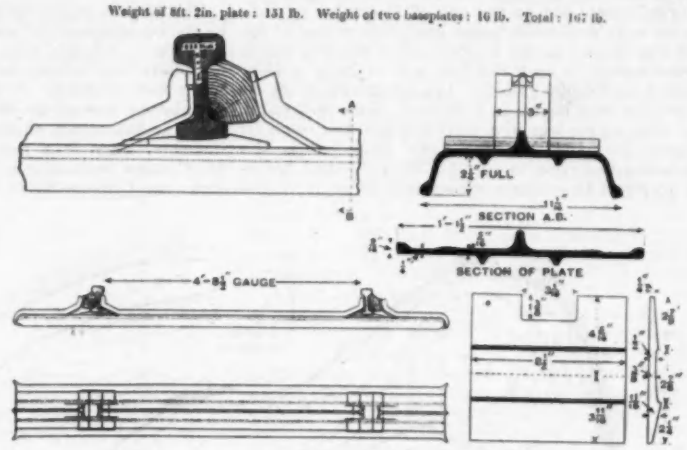
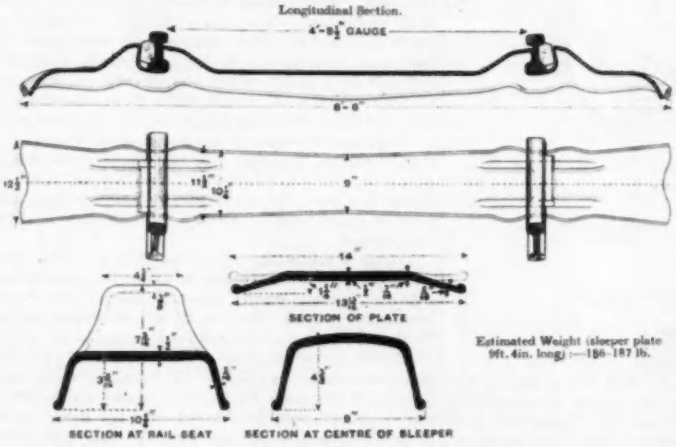


FIG. 13.—*Sandberg Type (1930 pattern used on G.W.R.)*



Estimated Weight (sleeper plate 9ft. 4in. long):—186–187 lb.

FIG. 14.—*Elsoe Vale "Unit" Type.*

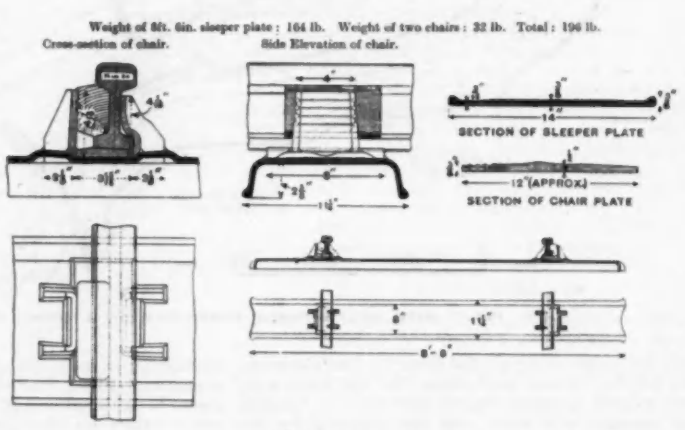

Weight of 8ft. 6in. sleeper plate: 164 lb. Weight of two chairs: 32 lb. Total: 196 lb.
Cross-section of chair.
Side Elevation of chair.
SECTION OF SLEEPER PLATE
SECTION OF CHAIR PLATE
12" (APPROX.)
8'-0"
SWAIN Sc.

FIG. 15.—*Workington Type.*

SIXTY YEARS AGO.

SUBMARINES and searchlights were separately discussed in our issue of December 29th, 1871. Dealing with illumination in warfare, we mentioned the ancient device known as a ground light ball. Such balls still formed part of our military stores. They consisted of cylinders filled with a mixture of sulphur, saltpetre, resin, and linseed oil. In some rare instances it was, apparently, the practice to insert an explosive charge in the ball, as well as the illuminating mixture, but, in general, the device, after it was thrown among the enemy, was so safe that it could be lifted on a spade and extinguished in a bucket of water. To remedy this obvious defect of the ground light ball several proposals were made to attach the receptacle containing the illuminating mixture to a parachute. One such device was invented by General Boxer, and was illustrated in our pages. It consisted of a spherical iron vessel divided internally by a partition. Above the partition and attached to it by chains was a calico parachute, while below it was a mixture of illuminating compound. The device was discharged from a mortar. At or about the highest point of its trajectory, a fuse blew the upper portion of the casing away from the lower and ignited the compound, which burned in the air beneath the now extended parchute. Discussing modern developments, we did not use the word "searchlight"—it had not apparen ly at that date been coined—but we mentioned Monsieur Serrin's "ingenious instrument," then being tried at Chatham, in which the two carbon points of an ordinary electric light were fixed at the focus of a parabolic mirror made of silvered copper. The device under trial was stated to be the only such light in this 1864. The sloop was sunk, but her attacker and her crew of nine also perished. Hand power generally applied to oars was the common method of propulsion in all these early inventions, but in 1853 Bauer, of Munich, designed a submarine to be driven by a gas engine and at the Paris Exhibition of 1867 a model was shown of a submarine boat propelled by compressed air. Reviewing the position, we contended that the solution of the problem of submarine navigation might be difficult, but that it did not appear to be impossible. The gas engine, we thought, might provide the required source of power, and compressed air might be taken down in the vessel to supply the needs of the crew and the engine. The greatest problem which we foresaw was connected with the directing of the submerged vessel towards its target. Even now the periscope cannot be said wholly to have solved that problem.

Canadian Engineering News.

Alberta Oil for Railway Fuel.

UPWARDS of 200 barrels of crude oil per day are now being taken from the Ribstone wells, in the Province of Alberta, for the use of the Canadian Pacific Railway in its locomotives on the mountain division between Calgary, Alberta, and Field, British Columbia. The railway company is stated to have found the fuel from the Ribstone area highly satisfactory, and is likely to increase its requirements in the near future.

Rebuilding St. John Harbour.

The first contracts for restoration of the port facilities at West St. John, New Brunswick, recently destroyed by fire, have been entered into with the Foundation Company of Canada, Ltd., and the Northern Construction Company, Ltd., both of Montreal, and work has already started. The present contracts are for the restoration of berths 5, 6, 7 and 14, 15, 16. There will be a lot of additional construction work to be got under way shortly, in order that the port facilities may be restored before the busy season next winter. Plans are now being worked out for the new sheds and grain conveyors.

New Process in Rail Production.

What is claimed to be a greatly improved process in rail production, which has been developed by Mr. I. C. Mackie, the chief of the metallurgical department of the Dominion Iron and Steel Company, has been adopted at the Sydney steel plant of the Dominion Steel and Coal Corporation. The important feature of the invention is said to relate to the discovery, after several years of intensive research, of the precise stage in the production of the rails when too rapid cooling results in "shatter cracks," from which transverse fissures subsequently develop when the rails are in use. In the new method, the cooling of the rails, before the critical stage is reached, is checked and regulated by cooling tanks, which are so arranged as to reduce the heat by carefully graduated degrees. From twenty-four to thirty hours elapse from the time they reach the tanks till they are ready for inspection tests.

Ontario's Northern Railway.

The railhead reached Moose Harbour, the James Bay terminus of the Temiskaming and Northern Ontario Railway, on August 31st. The final stretch of 100 miles of this line was undertaken in February, 1930, when it was predicted that steel would be laid into the town by September 1st, 1931. One of the biggest undertakings in completing the line from Coral Rapids, which is the present operating terminus, to Tidewater was the construction of a 1500ft. steel bridge spanning the Moose River. The main line of the Ontario Government's railway now extends for a distance of 450 miles northwards from North Bay to its new terminus, while the rail distance from Toronto is approximately 675 miles. The extension gives Ontario rail communication from the Great Lakes to the sub-Arctic sea. The country opened up is considered to have immense natural resources in its timber and pulpwood, gypsum, commercial clays, &c.

Transportation Problems.

A thorough and comprehensive study of the railway situation throughout the Dominion is planned by the Government. The two major railways have been, and are, heavy sufferers from the present business depression. Their earnings have been steadily declining, and from present prospects the end of the downward trend in traffic is not in sight. To offset this, the executives of the two railways are making a determined, and, to a large extent, a joint effort to reduce the cost of their service by cutting off uneconomical trains, discharging employees who can be dispensed with, curtailing steamship runs and effecting economies in their hotels. It is believed, however, that even greater savings can be achieved, and it is this extension and continuance of rigid economy that will form one of the central questions of an investigation to be undertaken by the Government.

Report on the Water Supply of Durban.

AN interesting and detailed Report, of which we have been favoured with a copy, has recently been prepared by Mr. Walter M. Campbell, M. Inst. C.E., M.I. Mech. E., the Durban Borough Water Engineer, on the investigations which he has carried out with a view to ascertaining the best direction in which to seek a new source of water supply for that town. We have pleasure in giving below a summary of the leading features of the Report. By way of introduction, however, it will be well to glance for a moment at the past history of the water supply of the locality.

In May, 1854, when Durban was proclaimed a Borough and when the population was only about 1200, the water supply was obtained from primitive wells, by hand pumps or otherwise. Although several attempts were made to obtain a regular supply from an outside source, it was not until September, 1883, when the population had risen to well over 16,000, that reports were submitted on five possible water schemes, and at the end of December of that year surveys were undertaken and plans prepared for what was known as the Umbilo River scheme, which was estimated to cost £33,300, and to have a daily capacity of 200,000 gallons. Constructional work on the scheme was begun in February, 1885, and water from that source was first delivered into the town on January 1st, 1887. Three years later, when the population had risen to over 23,700, it became necessary to resort to emergency measures to augment the supply by means of a pipe line from the Umhlatuzana River to the Umbilo headworks. In the same year it was decided to adopt what is known as the Umlaas River scheme, and water was first received by the town in July, 1891, from the first section of that undertaking, a water-borne sewerage scheme being started at the same time. The population had then risen to over 25,500. The second portion of the Umlaas scheme was completed in December, 1894, and the daily consumption of water was then 536,000 gallons. During 1900, by which time the population had more than doubled—55,731—and the daily consumption had risen to 2,750,000 gallons, a very severe drought was experienced, and the construction of a dam, called the Camperdown Dam, was decided upon as a temporary measure. That dam was finished in October, 1901, and for two years all apparently went well. Exactly two years later, however, there was a drought during which the total flow of the Umlaas River fell away to 1,144,000 gallons per day, and just over eighteen months later—in May, 1905—a severe storm broke over the coastal districts, which resulted in the complete demolition of the Umbilo dam and its appurtenant works. The foundation stone for a new Camperdown Dam was laid at the end of June 1906, but after six months' work construction was indefinitely postponed, and the site was ultimately abandoned as being geologically unsuitable.

In October, 1917, when the population was 83,650 and the daily consumption 5,738,219 gallons, severe floods occurred which so seriously damaged the waterworks that Durban was completely cut off from its source of supply, and emergency pumping from the Umhlatuzana River resorted to. Temporary repairs were effected and the Umlaas supply was restored, but in restricted quantity. Though the population had risen to over 91,600, the average daily supply was reduced to just over 4,200,000.

On January 1st, 1919, a Borough Water Engineer was appointed, and during that and the following year the Waterworks Department was reorganised, and the greater part of the works that had been damaged by flood were permanently repaired. Investigations and surveys for a new water scheme were also undertaken. In July, 1920, the Shongweni water scheme to obtain an additional supply from the Umlaas River was adopted by the Town Council, and the project was sanctioned by an Act passed in June of the following year. A year later constructional work on the scheme, which included the driving of several tunnels, was begun. Delays of one kind and another were experienced, and it was not until July, 1927, that water from this source was brought into service, the Vernon Hooper Dam being formally opened in the December of that year. Between April, 1928, and March, 1929—the population being then some 140,000 and the daily consumption about 9¼ million gallons—severe drought conditions prevailed in the Umlaas catchment area, which stressed the resources of the Shongweni works, and emphasised the limitations of the Umlaas River. The Town Council then decided to institute investigations with the object of formulating a new scheme for obtaining an additional supply, and Mr. Campbell's Report is the outcome of that decision.

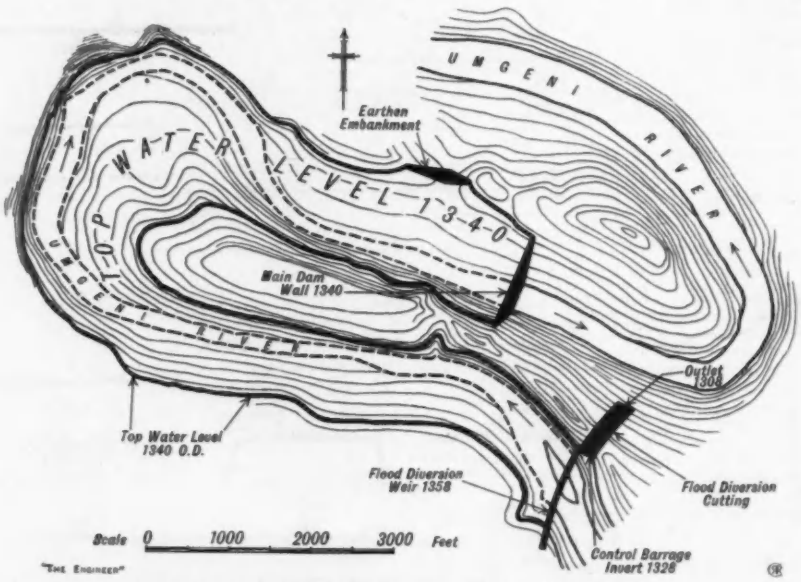


FIG. 1—SITE OF PROPOSED RESERVOIR ON UMGENI RIVER

FUTURE REQUIREMENTS.

The Report begins by estimating what are likely to be the requirements of water in the future. When the Shongweni scheme was adopted, it was not contemplated that, in ten years, the population would have more than doubled. It has, however, done so. The population served in 1920 was less than 100,000; now, as the result of the incorporation of outlying districts, there is a potential water population, in the Greater Durban area, of 218,900. The safe supply from the Umlaas River is 15,000,000 gallons a day, inclusive of a daily volume of 1,666,000 gallons compensation water. The daily *per capita* consumption varies between 60 and 80 gallons. Mr. Campbell does not consider an average consumption per head of 70 gallons excessive for a town like Durban with its semi-tropical climate. He therefore takes that figure as a basis in determining the future requirements. He estimates that the population in 1938 will not be less than 260,000, which would make a full call on the 15 million gallons per day available from the Unlaas River; any new scheme should, therefore, be in operation supplying additional water not later than the year 1939. It is not easy, he remarks, to forecast the increase in the population from 1938 onwards, but he considers that, on a conservative estimate, the population in 1950 would be about 350,000. On a basis of 70 gallons per head per day, the daily consumption would, by then, have risen to practically 25 million gallons. In 1959—twenty years after the completion of the scheme proposed in the Report—it is probable, he says, that the daily consumption would not be less than 30 million gallons per day, which means that any new scheme adopted should provide for a further 15 million gallons a day to add to the 15 million gallons now available from the Umlaas River.

FURTHER DEVELOPMENT OF UMLAAS RIVER CONSIDERED.

Before passing on to consider other sources of supply, Mr. Campbell explains why the Umlaas River cannot be further developed for supplying the Borough. In the first place, he states that, in his opinion, any attempt to raise the height of the Camperdown Dam would be quite unjustifiable. The structure was originally erected as a temporary wall, and is most unsuitable for any extension whatever. Moreover, the actual experience of the flow of the River during the last thirty years has definitely shown that no further storage provision at or near Camperdown would be justified. At the Shongweni Works, no provision has been made for raising the Vernon Hooper Dam, because, primarily, the geological conditions above the present crest level of that structure are most unsuitable for obtaining water-tight or stable foundations. Moreover, the river-flow records go to prove that, in dry years, there is not sufficient surplus flow to warrant a greater storage capacity than is already provided. On these and other accounts, therefore, Mr. Campbell's decision with regard to the Umlaas River is that the stage of full development has definitely been reached, and that no further capital outlay on that River would be warranted.

INVESTIGATIONS DESCRIBED.

The general investigations for a new source of supply were most exhaustive, and were pursued throughout an area comprising almost the entire Province of Natal. The three main river valleys which came under consideration were those of—(*a*) the Umkomaas River; (*b*) the Umgeni River; and (*c*) the Tugela River. In addition, some consideration was also given to the smaller rivers Elands, Illovo, and Umtovi. The map reproduced in Fig. 2 presents a comprehensive grouping of the schemes investigated with their respective catchment areas. The main classification of the Report is based on the three larger rivers, and coming into their respective classifications the schemes were investigated as follows:—

Umkomaas River	Upper Section	..	Scheme No. 1
	Alternatives	..	Schemes Nos. 1A, 1B, 1C
	Lower Section	..	Scheme No. 2
	Elands River	..	,, No. 3
Umgeni River	Upper Section	..	,, No. 4, Howick Falls
	,, ,,	..	,, No. 5, Albert Falls
	Lower Section	..	,, No. 6, Upper Table Mountain
	,, ,,	..	,, No. 7, Lower Table Mountain
Tugela River	.. .. ..		,, No. 8

THE UMKOMAAS RIVER.

Two main schemes with several alternatives were investigated:—An Upper Scheme, No. 1, with an intake on the river at such an elevation as would enable water to be diverted and conveyed across country into the Umlaas Valley, thus supplementing the Umlaas River flow; and a Lower Scheme with an intake at an elevation which would directly command and supply Durban.

Upper Umkomaas: Scheme No. 1.—We do not propose to follow Mr. Campbell in detail in these investigations. It will be sufficient to give his conclusions. With regard to the Upper project, he states that it became clear that, though advocated some years ago, it was never thoroughly investigated before, and now "turns out to be not merely difficult, but difficult to a point of non-feasibility on the grounds of prohibitive cost, erratic river flow, and the general unsuitability of the geological and physical conditions for the introduction of engineering structures." Mr. Campbell has therefore not the slightest hesitation in advising the Council that the Upper Umkomaas River will not provide a suitable scheme, and that its further consideration should be definitely and finally abandoned.

Lower Umkomaas: Scheme No. 2.—The surveys were carried downstream in order to determine if a scheme, which would directly serve the Borough, could be evolved. An intake site was selected on the River, close to the Josephine Bridge, at an elevation of 1571ft. above sea level. The catchment area serving the point chosen would be 1312 square miles, and the aqueduct distance to Durban about 57 miles. The valley in the neighbourhood, and for many miles up or downstream would not provide a suitable reservoir site, and to attempt to erect a dam would be extremely costly, because of unsuitable geological conditions, and because of the enormous burden of sand, mud, and boulders which is carried down during floods, and which would soon eliminate reservoir capacity. The intake works, too, would be very costly in order to provide for the safe passage of big floods. The project, according to the Report, could only be regarded as a diversion scheme for direct supply to the town. It would be dependent solely on the river flow without storage, and would be of uncertain value even on the estimated demand of 15 million gallons per day, frequent observations having shown the very low ebb to which the River falls in the winter months. On account, therefore, of the highly torrential and turbid character of the River in flood, and of its low winter flow, Mr. Campbell cannot see his way to recommend this scheme, or any of its alternatives, for further considerations. In fact, summing up the potentialities of the Umkomaas River as a future source of water supply for Durban, he is thoroughly convinced that it would be unsatisfactory from virtually every point of view.

Elands River: Scheme No. 3.—This scheme may be regarded as a subsidiary proposal, capable of providing a quantity much less than 15 million gallons per day to supplement the Umlaas River flow; the maximum catchment area available would be 148 square miles, and although it is an excellent stream, which runs with less turbidity than the larger rivers, the quantity of water available would not justify the cost. It is most improbable that a winter flow of even 5 million gallons per day could be relied upon.

UMGENI RIVER.

The Umgeni River, according to the Report, provides a more favourable outlook, and the investigations which have been carried out in connection with it have furnished most valuable information. The

River rises in the lower slopes of the Drakensberg Range, at an elevation of roughly 5000ft. above sea level. The geological formation in the neighbourhood is the Beaufort series of sandstone and shales, which is probably the most favourable among the strata in Natal for the retention of underground water. There is also ground for the assumption that some of the water falling outside the actual catchment area, finds its way underground to the Umgeni River. Mr. Campbell states that he has examined the Umgeni Valley as closely as possible right to the source of the main stream and its tributaries, and that he is satisfied that geologically, topographically, and in view of the sound agricultural practice that prevails, it is eminently satisfactory. The virtual absence of soil erosion in itself, he says, indicates that it is not being detrimentally affected by the overstocking and grass-burning that are causing so much denudation in other parts of the country, and, for that reason alone, if for no other, the Umgeni River furnishes a most eligible source of supply. The average rainfall is slightly more than 40in. per annum, reaching 50in. in the mountain section, and it is well distributed throughout the area. After carefully co-ordinating the Howick Falls river gaugings with rainfall records, and comparing them with the relative rainfall and river-flow records of the Umlaas River, it has been proved that the Umgeni catchment area, upstream than meet a daily demand of 50 million gallons. The Unlaas catchment area yields more than 4 per cent. of an average of about 35in. per annum, so that, with a higher rainfall, the Umgeni catchment area should, undoubtedly, yield more than 4 per cent.

The Umgeni River investigations covered four schemes finally selected from a number of alternatives that were route-surveyed, and their costs estimated. These schemes are classified into two Upper and two Lower Schemes, the upper providing for tapping the River in the upper reaches and diverting it into the Umlaas River, while the lower schemes would directly serve Durban.

Howick Falls; Scheme No. 4.—Scheme No. 4 would have its intake just above Howick Falls at an elevation of 3390ft., and would be served by a catchment area of 371 square miles. The aqueduct, which would be 30½ miles long, would pass round Otto's Bluff, and would divert the water into the Umlaas River, joining the latter near the bridge over the Maritzburg-Richmond Road. At first sight, the Report remarks, the scheme is quite favourable and from the main engineering standpoint it is certainly feasible. It is, however, condemned for various reasons, the principal, apparently, being that it would be impossible to provide adequate storage at a reasonable cost, so that it would be purely a diversion scheme. Even so, Mr. Campbell is unable to

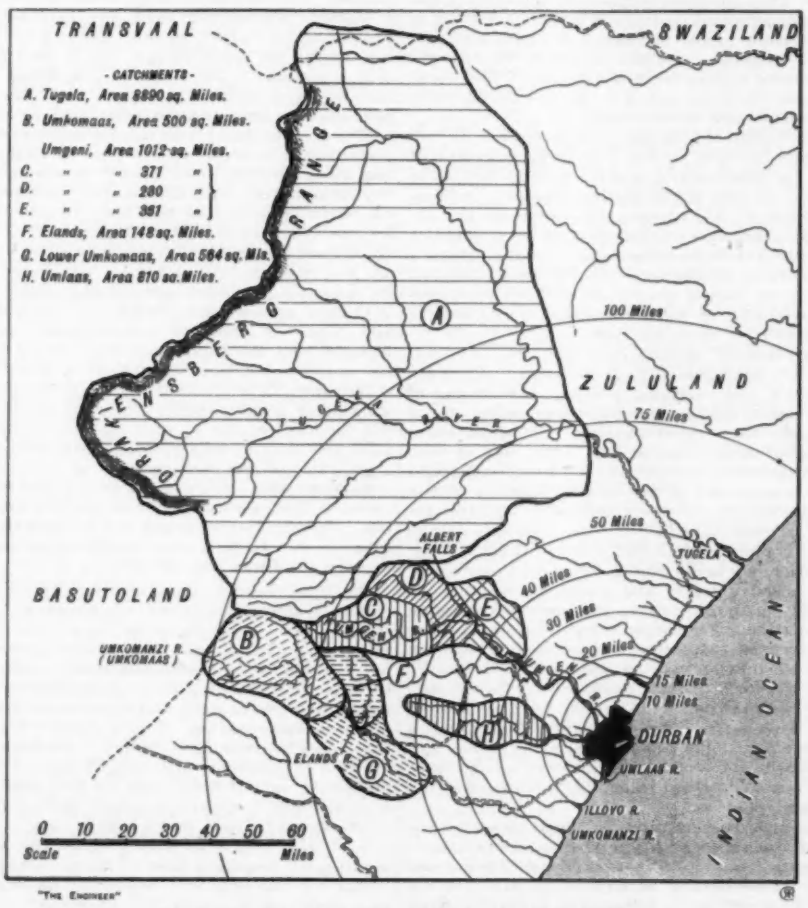


FIG. 2.—SKETCH MAP SHOWING CATCHMENT AREAS

of Table Mountain, would, when provided with storage accommodation—for which it is naturally well endowed—yield an assured supply of at least 50 million gallons per day. At the end of June this year, the flow into the Shongweni Reservoir was only 4½ million gallons per day—which represented the entire flow of the Umlaas River—whereas the flow of the Umgeni River at Table Mountain was, at the same time, over 40 million gallons per day. The respective areas draining to these points are 310 square miles in the case of the Umlaas River and 1012 square miles in the case of the Umgeni River, so that, with a little over three times the Umlaas catchment area, the Umgeni is productive of practically ten times the flow of the Umlaas. "This," remarks the Report, "is the best criterion that can be offered of the favouring conditions of the Umgeni Valley because, although in neither case has the absolute minimum flow been reached, in both cases the flow is down to 'spring' or 'groundwater' yield, as there had not been any rain of consequence for at least two months. It is reasonable to assume, therefore, that as 15 million gallons per day can be derived from the Umlaas River, with the storage provided by the Shongweni Reservoir, a maintained daily figure of at least 50 million gallons may be expected from the Umgeni River, if adequate storage provision is constructed."

The average annual rainfall for the Umgeni River is, as has been explained, 40in., and, if only 4 per cent. of the aggregate rainfall reaches the river, the resulting quantity, maintained by conservation, would more recommend it because a reliable and well-maintained supply could not be secured, and certainly would not, he says, warrant the construction of works to convey more than 10 million gallons per day to the Umlaas River; in fact, reliance on that quantity would not be justified owing to existing riparian rights.

Albert Falls: Scheme No. 5.—Proceeding downstream, the next scheme investigated was that at Albert Falls. This scheme would have its intake weir just above the Albert Falls at an elevation of 2070ft. The aqueduct would follow the right bank of the River to Bayne's Drift and join the Sterk Spruit—the main tributary of the Umlaas River—near Hammarsdale Station. This aqueduct would have a total length of 32 miles and would include a tunnel 8 miles long. The bed of the Sterk Spruit at the point of confluence, being naturally only the drain for about 20 square miles of catchment area, would require very considerable widening and canalisation in order to accommodate the much greater quantity of water that would be diverted into it from the Umgeni River.

The scheme would be served by a catchment area of 627 square miles, and could probably be relied upon to yield 15 million gallons per day with reasonable safety. It must, however, be looked upon as simply a daily flow scheme of which the real test would be the lowest limit of flow likely to be experienced. Storage reservoir construction would not be readily feasible at or near the Albert Falls, and as the cost of the scheme as outlined—£1,094,368—does not include the formation of a storage reservoir, it must "be regarded as a scheme that would not justify the expense, and in any case would take too long to construct on account of the eight-mile tunnel, whilst further development would be precluded."

Upper Table Mountain—Scheme No. 6.—The starting point of Scheme No. 6, which is served by a catchment area of 1000 square miles, stands at an elevation of 1380ft. above sea level. The proposal would include the formation of a reservoir by means of a concrete dam, some 90ft. high by 1250ft. long, which would impound about 3000 million gallons of water. The aqueduct would have to be 38¼ miles long and would have to pass through some of the most rugged country in Natal. The longest tunnel would, however, be less than two-thirds of a mile. The scheme, which would cost, on a preliminary estimate, £1,306,192, would provide for an assured daily supply of 15 million gallons, and it could be developed to provide a much greater quantity. "It is," to use the wording of the Report, "a favourable scheme, but a much more favourable alternative was available a few miles downstream."

Lower Table Mountain—Scheme No. 7.—The alternative referred to is that known as the Lower Table Mountain Scheme, or Scheme No. 7. In outline, it was the alternative considered along with the Shongweni scheme in 1920–21. The more detailed survey, which has now been possible, has, according to the Report, "thrown up this scheme into strong relief, and to much better advantage than our former somewhat limited knowledge had indicated." It would consist of a storage reservoir formed by a concrete dam some 120ft. high and 1300ft. long, which would be capable of holding up some 5000 million gallons. The aqueduct would be 36 miles long and would deliver into the existing South Ridge Service Reservoir. The catchment area draining to the site would be 1012 square miles and the top water level at the proposed dam would be 1250ft. above the sea.

A distinctive feature of the scheme is that it would be possible to provide flood diversion works at comparatively small expense, the reason being that the river, in the neighbourhood of the proposed dam, assumes a shape and pursues a route through country which are peculiarly favourable for the purpose. It will be seen from Fig. 1 that, at the point chosen, the bed of the river flows through steep banks in the form of an S. The suggestion is to throw a curved diversion weir across the river at the beginning of the double bend and to form a flood diversion channel by excavating the sloping bank on the right-hand side of the weir for a comparatively short distance. In the middle of the S there is to be a main dam of concrete thrown across the river and it will be necessary to construct an earth embankment to close a depression in the bank and complete the reservoir. As will be observed, it will be possible to divert as much flood water as may be deemed desirable and to discharge it into the river again below the main dam. It will therefore be possible entirely to prevent silt-laden flood water from entering the reservoir.

The estimated cost of obtaining an initial supply of 15 million gallons per day is £1,181,103.

TUGELA RIVER.

The area draining to the Tugela River is very large; in fact, it amounts to more than half of the whole of Natal. The western boundary is the Drakensberg Range, nearly 200 miles long, in parts of which the annual rainfall amounts to 100in. The Range, in fact, is probably the most reliable source of riverflow in the Union of South Africa. The geology of the area, however, is of a very varied character, all the geological formations met with in Natal being represented. Igneous rocks are found on the Drackenberg Range, while lower down there are the Stormberg, Beaufort, Ecca Shales, glacial conglomerate, and Table Mountain series, intrusive granite and limestone. The varied character of the geological formations passed through by the main river and its tributaries has a most important bearing on its adaptation for a municipal water supply. For instance, heavy storms in certain districts would lead to extensive soil erosion and consequent heavy turbidity in river flow. Similarly, prevalence of rain in certain other localities would lead to variations in the hardness of the water, so that the designing and operating of suitable and adaptable purification works for such variations would be attended with no little difficulty and expense. "It is necessary," comments the Report, "to take this most important factor into full account in considering the merits of the Tugela River, because, although from the viewpoint of quantity, it would be almost unrivalled in South Africa, its extensive drainage field introduces wide variations in character and quality, thus prejudicing the production of water of uniform quality."

Tugela River: Scheme No. 8.—It was found on survey that, in order to serve the Borough from the Tugela River by the shortest possible gravitation route, it would be necessary to proceed to a point of intake on the River almost due north of Krantz Kop, at a distance of, approximately 89½ miles from the sea—river mileage. The scheme, as surveyed, would provide for a low-barrage intake in the river bed, at an elevation of 950ft. above sea level, fitted with sluice gates designed to pass accumulating silt downstream, with the necessary purification works about 5 miles from the intake. The aqueduct

would be about 98 miles long, and comparatively little tunnelling would be required as the route, generally, would be favourable. The construction of a storage dam at the intake site would not be feasible. The estimated cost of the scheme as at present prepared, would be £1,671,136.

FINAL SELECTION.

Mr. Campbell submits in his Report that the final selection should lie between scheme No. 7—Lower Table Mountain, on the Umgeni River—and scheme No. 8—the Tugela River. The Umgeni River scheme may be relied upon to provide—through the aqueduct allowed for in the estimate of £1,181,103—a daily quantity of 15 million gallons, and it would be capable of eventual extension to provide at least 50 million gallons per day, which, however, would necessitate the construction of the Upper Table Mountain Dam.

The Tugela River has the large catchment area of 8890 square miles above the proposed point of intake. It could safely be relied upon to provide 50 million gallons per day without any necessity for storage and therefore, the danger of silting, which follows in the train of erecting impounding dams in the neighbourhood, would be non-existent. In this respect the Tugela River would appear to have the advantage of the Umgeni River, because, in the latter case, an impounding dam would be essential. As has been explained, however, trouble from silting as the result of floods will be avoided by the possibility of making efficient flood-diversion works. Hence, in this most important point, both rivers may be regarded as equally favourable. The Umgeni scheme has, however, the decided advantage over the Tugela scheme that the raw water as impounded in the storage reservoir would receive prolonged settlement, which would be invaluable as a preliminary to filtration, facilitating that process and minimising its cost in a very large measure. On the other hand, the extraction and purification of water from the Tugela River, without storage, presents the similar and very difficult problem of sedimentation and filtration, of which there was full experience on the Umlaas River before the construction of the Vernon Hooper Dam.

All other considerations aside, however, the determining factor in the comparison of the two schemes, must be the cost. On the basis of a daily supply of 15 million gallons, the respective capital costs, as shown by the preliminary estimates, are, as has been seen, £1,181,103 for the Umgeni, and £1,671,136 for the Tugela. Ultimate development would, however, aggravate the disparity. In round figures, the eventual comparison in aggregate capital expenditure for 50 million gallons per day would be :

For the Umgeni River	£3,000,000
,, Tugela River	4,500,000

On all grounds, therefore, Mr. Campbell states that he can "unreservedly and with full assurance" recommend that the Lower Table Mountain scheme on the Umgeni River should be adopted in the present instance. He adds, however, that if, at some future time, the resources of the Umgeni River become insufficient to meet requirements, the Tugela River will still be available as an admirable source of supply for development on a scale and at a cost more commensurate with the resources of a much larger population.

There is a great deal more in the Report, which is among the ablest and best reasoned of its nature that it has been our good fortune to study. Enough has been said, however, to indicate the main points dealt with.

BOOKS OF REFERENCE.

An Almanack for 1932. By J. Whitaker, F.S.A. London : J. Whitaker and Sons, Ltd., 12, Warwick-lane, E.C. 4. Price 6s. net.—The sixty-fourth annual issue of this volume needs no introduction, as for many years "Whitaker" has been used by all and is probably the best-known and most valuable book for general statistical information published in this country. The new edition follows the same lines as its predecessors, and all the particulars therein, including facts concerning the new Government, are the latest available. In order that the varied contents may be available for instant reference, the index has been enlarged and now contains some 20,000 references.

The South American Handbook, 1932. Edited by Howell Davies. London : Trade and Technical Publications, Ltd., 14, Leadenhall-street, E.C. 3. Price 2s. 6d. net.—For its ninth edition this valuable book of reference has been completely reset and the publishers have taken the opportunity to revise thoroughly the matter it contains. In spite of political disturbances, the information given is up to date, except in a few unimportant cases. Owing to it being the only annual handbook on South America, the officials of the various countries, shipping companies, trade organisations, &c., take a definite interest in its compilation, and the information it gives can be accepted as authoritative. The publishers are to be congratulated upon once again having produced a book of great value to all who do business with or travel in South America.

Use of Self-propelling Vehicles for Railway Passenger Traffic.

By F. W. GREEN, A.M.Inst.T.

PRIOR to the advent of road competition railway officers had paid a good deal of attention to the utilisation of a self-contained and self-propelling unit for passenger traffic working. Several types were introduced and were employed to replace trains made up of coaches with a separate engine where traffic was light. As far back as 1849 the Eastern Counties Railway had a "rail motor coach" working, but it was not until about the commencement of the present century that their use became a serious and recognised part of the railway companies' programme.

The Great Western Railway Company was foremost in utilising what came to be known as "rail motor cars," which consist of a single vehicle, with an engine at one end, two passenger-carrying sections divided by vestibule into smoking and non-smoking compartments, a luggage and parcels section and a small compartment at the other end, from which the driver can control the engine and the automatic brake. These cars vary in their lengths from 50ft. to 70ft. and in their capacity from forty-five to sixty-three seats. Their self-contained construction eliminates the time and line occupation entailed by the engine running round its train at terminal stations or reversing points. The rail motor is capable of propelling or hauling a trailer, to which the driver's special control arrangement is extended. The working principle of this miniature steam train is the same as of a multiple-unit electric train.

The utilisation of petrol, petrol-electric or oil-electric cars has not, so far, been very extensive or successful in this country, and the current figures for "rail car" vehicles in the British Isles are :—Steam, 162 (L. and N.E., 85) ; petrol, 10 ; petrol-electric, 2 ; total, 174. Abroad, however, about 1000 oil-engined rail cars are in use, and the experience with them is reported as being satisfactory. Their utilisation abroad is undoubtedly largely due to the lack of cheap locomotive coal, and, in some countries, to the lack of water suitable for steam raising.

The advantages arising from the use of "rail motors" are their flexibility in working, particularly at terminals and reversing points ; the saving of platform, ticket issuing and collecting staffs ; owing to their short construction they can serve short "halt" platforms, reducing the initial cost of such halts. A driver to control the working, sometimes from the reverse end of the vehicle, together with a fireman to attend to the engine and a guard are required on such vehicles, so that there is no wage saving as compared with full train working. Their working economy arises from low coal consumption.

Their disadvantages are increased liability to engine failure, thus throwing the passenger-carrying accommodation out of use, which also happens during repairs and overhauls ; their limited hauling capacity available to cope, on varying gradients, with "tail" traffic in the form of milk trucks, horse boxes, &c., and the unsuitability of the vehicle for even limited shunting movements. The real utility of a rail motor car is limited to light passenger-carrying traffic, and for this reason some of the original rail motors have not been renewed, whilst others have been converted to "trailer" coaches.

To overcome the disadvantages, but at the same time to retain the advantages, a type of self-contained train, known as the "auto" or "push-and-pull" train, was evolved. It consists of an engine—usually 2–4–0 T or 0–4–2 T—which can be formed and worked between open or corridor "trailer" coaches, being capable of control from the leading end of the foremost trailer. A limit of two coaches in front of the engine is imposed by a difficulty in ensuring satisfactory control by the driver by mechanical means, but the Nord Railway of France has introduced an electrical form of control which opens up possibilities of a greater number of vehicles being formed in an "auto" or "push-and-pull" train, thereby securing increased passenger-carrying capacity. The "auto" engines are detachable from the trailers and can be used for shunting purposes, or to run a separate goods train between passenger trips.

The engines of the "rail motor" and the "auto" trains, being steam operated, are subject, from a traffic operation point of view, to the limitations of requiring time for taking coal and water, particularly the latter, and also daily shed attention. In these respects multiple-unit electric trains offer superior working advantages.

To combat road competition a frequent and regular service for passengers by these self-propelling vehicles —"rail motors" and "auto trains"—stopping at all stations is frequently advocated, and such services have achieved marked successes in certain localities where circumstances are favourable. Railways, however, suffer from the initial disadvantage that through lack of foresight or capital on the part of the original promoters, or in some cases through opposition from local bodies and landowners, their lines and stations are often remote from the towns and villages they serve. The road companies can offer a door-to-door service which a railway by its physical limitations cannot possibly offer, and however frequent the rail service may be, it is not likely to attract sufficient traffic to recoup the additional train working expenses, which increase per trip with steam working. With electrical working the more frequent the trips the less is the average cost of each trip.

Further, it is a matter of experience that, speaking generally, up to approximately 4 miles, road conveyance is preferred to railway travel, however frequent the service, but beyond that distance the comfort factor—as afforded by a train journey—tends to predominate over the convenience factor—as afforded by a road journey. Again, whilst a frequent service stopping at all stations will be tolerated without complaint up to about 10 miles, beyond that distance passengers demand non-stop trips.

The location difficulty in a few cases can be counteracted by the quotation of cheap return fares, lower than the road fares.

A number of halts—that is, short unstaffed platforms sometimes formed up at ground level—have been and are being constructed and served principally by "rail motor" and "auto" services at points where there is a likelihood of passenger traffic being secured to the railway. The Great Western Company, for example, opened twenty-seven such "halts" in 1929, twelve in 1930 and twelve this year.

To get a rail service to the centres of population and industry where the railway is unfavourably located, various efforts have been made to design a suitable vehicle for road and rail use, making a part of its journey by rail and a part by road ; but so far no great success has been achieved in this direction. The L.M.S. "Ro-Railer" coach was designed with this object, and other similar projects have been and are being tried abroad.

To run a frequent and regular rail service entails practically complete occupation of running lines, and it is obvious that such a service should not be inaugurated without careful consideration of the circumstances, as the final result may be a serious loss to the railway company concerned. There are several points which have to be passed in review, as, for example, the potential passenger business. In sparsely populated agricultural districts travel is limited, and is often confined to the market days and fairs. A frequent service would not create business and the running of additional trips would be unremunerative. Again, in populated areas, a frequent service would create difficulties in the working of freight trains, as few intervals would be left for the running of such trains. From a manufacturer's and trader's point of view, and also from a railway revenue earning point of view, it is most important that every possible facility should be given to this valuable traffic to ensure prompt working. Freight traffic should not be hindered by the running of a frequent passenger service, which may or may not be remunerative.

On most branch lines the freight and mineral traffic is the predominant consideration, passenger traffic often being light in proportion owing to scanty population, and the motive power has to be provided to cope with the heavy traffic and has to take the form of a steam locomotive worked by one or two sets of men, according to the time extent of the branch service. This locomotive also works the branch passenger traffic, occasionally as a "mixed" passenger and freight train. If a self-propelling vehicle were used on the branch to run a regular and frequent passenger service under such circumstances, two power units with additional sets of men would be employed on the branch, as the special passenger unit could not work the coal traffic, for example, and unless the passenger traffic were sufficient to cover the additional cost arising from the employment of an extra unit, the financial result might be a loss to the railway company, even though additional passenger traffic were secured by the more frequent service. With two power units working on the branch, additional expenditure on signalling facilities might also be necessary.

The Ministry of Transport requirements relating to railways preclude the running of a passenger carrying service without some form of signalling and block telegraph—or train staff—equipment in order to prevent more than one train being in a block section between two signal-boxes on the same line at the same time. As compared with the initial and annual expenditure entailed by this requirement, when road traffic outgrows the facilities, road widenings, by-pass roads, new bridges, &c., and also police for "signalling" the road traffic, are provided at public expense, and this reacts in an unfavourable manner against the further development by railway companies of passenger services and facilities.

If the passenger business is sufficiently good to cover all additional charges, there are two courses open to a railway company desiring to maintain efficient passenger and freight train working, viz., either to lay down, often at considerable cost, additional running lines, or, alternatively, to add to its signalling equipment in order to increase the capacity of existing lines. In certain conditions both courses may be necessary, and an appreciable additional charge for interest on capital, maintenance and renewal and also for staff, would be created, most or all of which should be debited against the passenger service, which, as mentioned above, may create a net loss on a service showing appreciable business.

Railway and Road Matters.

THE successor to Mr. D. McLellan, as divisional engineer (Scotland), London, Midland and Scottish Railway, is Mr. A. H. McMurdo, the assistant engineer (permanent way) at the headquarters at Euston. Until two years ago Mr. McMurdo had been wholly in Scotland, as he joined the Glasgow and South-Western in 1902, and went thence to the Highland. On the formation of the London, Midland and Scottish he was made district engineer at Inverness.

ALL the creosoting work for the Southern Area of the London and North-Eastern Railway is being concentrated in a new yard, just opened at Bo'ness. There is stacking accommodation for 410,000 sleepers and for about 160,000 cubic feet of crossing and other timbers. Of the two pressure cylinders one is 113ft. long and will hold twelve bogie trucks carrying 700 sleepers, and the other is 65ft. long and takes seven bogies with 400 sleepers. The tanks for storing the creosote have a capacity of 57,000 gallons. The sleeper boring and adzing machines are in close proximity to the cylinders so that there is a minimum of labour in transport. It is expected that the annual output will be 275,000 sleepers.

THE Ministry of Transport railway statistics for September, noted herein on December 18th, gave also the results for the first nine months of the year. In comparison with the same period of 1930 there was a decrease of 4·9 per cent. in the number of passenger journeys and of 8·1 per cent. in receipts from passengers. The total passenger traffic receipts fell by 7 per cent. Passenger train mileage was reduced by 1·6 per cent. The goods traffic suffered a drop of 13·2 per cent. in tonnage and of 9·9 per cent. in receipts. General merchandise fell by 12·4 per cent. in tonnage and 9·9 per cent. in receipts; minerals—other than coal—and the merchandise in classes 1 to 6 fell 19·9 per cent. in weight and 16·8 per cent. in receipts, and coal, coke and patent fuel decreased by 11·3 per cent. in tonnage and 6·4 per cent. in receipts. There was a decrease of 6·6 per cent. in the goods train mileage. The average train load fell from 127 to 124½ tons and the net ton-miles per engine-hour from 449½ to 447½.

WHILST there were many serious road accidents in the London area and a fatal aeroplane crash in Wiltshire as a result of the dense fog on Friday and Saturday last, the 18th and 19th instant, only one serious railway accident was reported. As a London, Midland and Scottish passenger train from Fenchurch-street to Tilbury, on Friday evening, was running between Barking and Dagenham Dock stations it collided with five wagons and the brake van, which, owing to a broken draw-bar, had become detached from a goods train which had preceded he passenger train. One passenger was killed and another was seriously injured. The guard of the goods train was subsequently found to have been run over. He had evidently gone back along the line to lay detonators on the rail to protect the obstruction caused by the vehicles that had been left behind. The Ministry of Transport inquiry was begun by Lieut.-Colonel Mount on Tuesday and the coroner opened his inquest on Wednesday last.

THE fatal accident on the 18th instant at Dagenham, mentioned above, is the sixth fatal train accident of the present year and the fourth such in which passengers have lost their lives. The latter have been Carlisle on January 3rd, Leighton Buzzard on March 22nd, Fakenham on May 27th, and Dagenham on December 18th. The two accidents in which trainmen, but no passengers, were killed, were those at Northumberland Park on January 7th, and on the Clacton branch on the 16th of the same month.

THE announcement is made by the London and North-Eastern Railway that, as from January 1st, there will be no passenger train service—there are only two trains in each direction now—between Cudworth and South Howden on its Hull and Barnsley section. The length in question is 28½ miles, and so is more than one-half of the whole of the 51½ miles, and six stations out of fourteen are to be closed for passenger traffic. The Hull and Barnsley Railway was a very ambitious scheme that never reached its aims. It was promoted by the coal interests in South Yorkshire to compete with the North-Eastern to carry coal for shipment at Hull. Its western terminus was at Cudworth on the Midland, and it never reached Barnsley, even by running powers, nor, as later intended, Huddersfield and Halifax. In keeping with its ambitions, it had, originally, the long name of the Hull, Barnsley and West Riding Junction Railway and Dock Company. Mention of the last part of this title leads to the remark that it had a very fine piece of property in the Alexandra Dock at Hull. In view of financial assistance rendered the Hull Corporation had two directors on the board. The Hull and Barnsley was absorbed by the North-Eastern Railway as from April 1st, 1922.

ON Sunday, August 30th, a third-class corridor coach which was conveying a theatrical party for Scarborough arrived at York. The train reached No. 14 platform road at 3.25 p.m., and the vehicle was due to leave at 6 p.m. from No. 10 bay line. It had, therefore, to be taken from one side of the station to the other and across the main lines to and from the North. The engine came off at York, where it had to be turned and be ready to leave again at 4.17. There were three shunters eventually concerned in the movement of the coach in question, and the first of them detached the coach and two other empty vehicles from their train and told the driver of the engine to place the two vehicles on the up engine line and then to take the loaded coach to No. 10 line. Not knowing what the first shunter had arranged, a station inspector told a second shunter to deal with the special vehicle. The latter man had his own ideas and proceeded to put them into effect. In doing so he failed to tell the signalman that the single coach would be left standing on the engine line. The latter man later asked if the engine line was clear and learnt, on the strength of information given by a third shunter, who was thinking only of the two empty vehicles, that the engine line was clear. As a consequence, a light engine was admitted on to the engine line and collided with the special coach. Lieut.-Colonel Woodhouse inquired into the accident, but his report makes no recommendation—such as track circuiting—beyond a revision of the rules as to the working of this engine line.

Notes and Memoranda.

A VERY useful leaflet on the extraction of pebbles from clay, to make it satisfactory for ceramic work, has just been issued by the Ohio State University.

SOME 142,500 lb. of nickel, in the form of alloys, have gone into the new Waldorf-Astoria Hotel in New York City. Almost 175,000 lb. of monel metal, which contains two-thirds nickel and one-third copper, have been used for kitchen equipment and for other service uses. Fully 105,000 lb. of 20 per cent. nickel-silver have been used for plumbing fixtures, and an additional 45,000 lb. of 10 per cent. nickel-silver have been used for decorative trimmings.

ACCORDING to a contribution by H. Grubitsch in *Stahl und Eisen* for September 3rd, the solubility of Armco iron in chemically pure Zn is less than 0·5 per cent. below 470 deg. C., regardless of the length of time of contact, but above 480 deg. it rises rapidly to a maximum, depending on the time of contact, at 495 deg., and then falls to a minimum at 515 deg., according to the time of contact. With further rise in temperature the solubility rises again almost in linear proportion and becomes much less dependent on the time, which rapidly decreases.

FLOW tests on a 60in. reinforced concrete sewer constructed in 1929 by the Second River Joint Meeting in Essex County, New Jersey, showed, according to E. T. Killam, of New York, an average value of the coefficient of roughness, *n* in Kutter's formula, of 0·014 when the depth of flow was about one-third the diameter. Velocities in the test length of 2209ft. were measured directly by partly submerged surface floats and by the use of eosine dye, and were in the vicinity of 4ft. per second. Surface slopes had an average value of 0·00172 slightly less than the slope of the invert.

ONE thing to remember in silver soldering is, says Mr. A. Eyles, of the L.M.S. Railway, to remove the torch flame as soon as the brazed joint is completed, and then immediately to immerse the piece in cold water. By thus doing, the flux is disintegrated—if the brazed joint is allowed to cool slowly the flux usually sets into a hard vitreous film difficult to remove. A little sulphuric acid added to the water used for quenching greatly assists removal of the flux and scale. Joints may be cleaned by filing, grinding or polishing, and then may be burnished if necessary.

USE is made in the United States Navy of a so-called red-lead paint for priming coat of steel, which is a compound paint containing as pigment a mixture of red lead, zinc oxide, iron oxide, and magnesium silicate. Aluminium stearate is used in the vehicle to assist in holding the pigment in suspension to prevent settling. This paint has the advantage of being considerably lighter in weight and cheaper than straight red-lead paint, and can be made up and issued ready mixed; also having comparatively smaller amounts of red lead, the danger of lead poisoning is correspondingly reduced.

THE system of sludge digestion, in which valuable pioneer work has been done by the Birmingham Tame and Rea District Drainage Board, is being extended from the Board's headquarters at Saltley to a subsidiary sewage treatment centre at Colehall, near Yardley. The gases evolved in the digestion process are to be utilised for power as in the older plant. Seven primary sludge digestion tanks are being installed, each 61ft. by 31ft., equipped with floating gas collectors of wrought iron, covering the whole area of the tank, and connected with these are four secondary tanks of the same size. The sanctioned outlay is £30,500. It is anticipated that the plant, which is designed to treat 50,000 cubic yards of crude sewage a year, will be put into commission next autumn.

THE water power industry in Canada supplies nearly the entire energy requirements of the country, exclusive of that utilised for steam railways, automobiles, &c., and as a further measure of its importance it may be mentioned that the capital investment involved is rapidly approaching a billion and a-half dollars. The records of the Dominion Water Power and Hydrometric Bureau, Department of the Interior, show that during 1930 upwards of 20 billion kilowatt-hours of energy were produced, which, using the figure for the average coal consumption per kilowatt produced in the public utility plants in the United States, indicates an actual saving of 17,500,000 tons of coal in 1930. When we consider that for a stretch of upwards of 2000 miles across Canada no coal mines exist the value of this saving becomes apparent.

SOME experiments have been made by Messrs. M. Luckiesh and L. L. Holladay, of the General Electric Company of America, on the relative reflecting powers of paints towards visible light and biologically important ultra-violet radiation. They find that those which poorly reflect the ultra-violet radiation are zinc oxide, titanium pigment, lithopone, and tin oxide. Pigments which fairly well reflect ultra-violet radiation of the desired wave lengths are magnesium oxide, magnesium carbonate, calcium carbonate, silica, asbestine, and china clay. Some of these are lacking in body. Lead carbonate or white lead, commonly used in paint, moderately reflects the desired ultra-violet radiation. Of course, the vehicle in which pigments are suspended is very important. Some vehicles commonly used are not satisfactory, although, if used sparingly, some may be fairly satisfactory.

AT the request of the British Electrical and Allied Industries Research Association, an investigation of the strength at high temperatures of cast and forged steel, as used in turbine construction, was undertaken in the engineering department of the National Physical Laboratory as part of the general programme of work for the Committee of the Department of Scientific and Industrial Research appointed to supervise researches on the behaviour of materials of high temperatures. A report, price 9d., has now been issued by the Department containing the results of short-time tensile tests and creep tests carried out on a 0·30 per cent. carbon cast steel and a 0·39 per cent. carbon forged steel over a temperature range of approximately 400 deg. to 650 deg. Cent. Full tensile properties and the stresses corresponding to rates of creep down to 10^{-8} inch per inch per day have been determined. The results are given in numerous tables and curves.

Miscellanea.

THE sales of motor cars in the United States are said to have fallen in 1931 by over 50 per cent.

THE Winburg, South Africa, Municipality has decided to expend £10,000 on an electric supply scheme.

ARRANGEMENTS have been made for the reopening of the Bowsan, Cinderford, colliery in the Forest of Dean, which has been idle for forty years.

A FACTORY for making boilers is being put up at Kraljevica, on the Jugoslav coast, by the Adriatic Shipbuilding Company, in conjunction with Yarrow's, of Glasgow.

THE Lord President of the Council has appointed Mr. F. S. Sinnatt, D.Sc., F.I.C., to be Director of Fuel Research under the Department of Scientific and Industrial Research.

THE Ministry of Transport states that the number of motor vehicles registered officially for the first time in October last was 18,292, as compared with 20,720 for the same period of the year 1930.

THERE is a proposal on foot to organise a ferry service from the mainland, in the neighbourhood of Lymington, to the Isle of Wight, and it is said that a crossing of 1½ mile will be covered in seven minutes.

A FACTORY for the manufacture of typewriters is to be put up in Toronto, Canada, by the Underwood Company, while the works of the Remington Company, in the same city, are to be extended.

ALL thoughts of proceeding with the St. Paul's Bridge scheme over the Thames were abandoned at a meeting of the Corporation of the City on December 17th. Financial considerations are said to be the cause.

THE triennial award of the Coopers Hill War Memorial Prize and Medal, which fell in 1931 to the Institution of Electrical Engineers, has been made by the Council to Dr. M. G. Say, Ph.D., M.Sc., A.M.I.E.E., for his paper on "High-voltage Underground Cables."

A RATHER striking piece of publicity has just been issued by the Yorkshire Electric Power Company, in the form of a map which shows that over one-third of the population of England and Wales resides within 60 miles radius of their centre near Dewsbury, while half the population is within 120 miles. It is said, also, that the area contains 100 million tons of iron ore and the best coal in England.

ELEPHANT transport has formed the Indian method of carrying teak logs from the forests of Burma to the river-side for generations, but this picturesque system is, says *Indian Engineering*, now giving way to the march of mechanisation. Two Thornycroft rigid six-wheelers equipped with special trailers provide the modern transport method in one area. The trailers have been designed to allow of extension to accommodate the variable length of timber, and successful trials of the new vehicles were carried out before they were accepted for shipment.

THE Council of the Institution of Electrical Engineers has appointed a special Technical Committee to obtain papers on radiological and electro-medical subjects, and to deal with such other matters as may be referred to it by the Council. The aim is to stimulate and foster interest in the electrical engineering aspect of radiology. The Committee, which is representative of electrical engineers, medical men, and radiographers, is at present engaged in obtaining papers on the above subjects for reading before the Institution during the session 1932–33 and subsequent sessions.

EXPERIMENTS are being conducted at the plant of the Western Dominion Collieries near Estevan, Saskatchewan, with a view to the production of by-products from lignite. The tar, about 8 tons of which are now being produced daily, yields, when distilled, a lignite pitch, which can be used for binding material for the briquettes. Further distillation produces a clear tar, and, still further, a crude carbolic acid. Another prospect, it is stated, is a light oil which may be obtained by "washing" the gas, and this can also be broken up into several component parts, such as benzine and ammonia. No immediate installation of the costly equipment necessary for the manufacture of the various by-products is anticipated. Briquettes are, it is said, already being produced satisfactorily from the lignite.

THE s.s. "New Northland," the flagship of the Clarke Steamship Company's passenger fleet, is to sail from Halifax on January 8th on a Canadian Trade Exhibition cruise to the West Indies. The vessel will be loaded with Canadian products, prominently displayed, and it is expected that the ship will carry representatives of every branch of Canadian industry producing goods that the countries to be visited need and must import. Nearly all of the countries to be visited on the two months' cruise, which is designed solely to promote trade between those countries and Canada, are members of the British Commonwealth and lie mostly in the Caribbean range. The itinerary of the cruise includes calls at Bermuda, St. Kitts, Antigua, Montserrat, Dominica, St. Lucia, Barbados, St. Vincent, Grenada, Trinidad, Georgetown, Kingston, Havana, and Nassau.

TEN years ago communication between points within the North-West Territories of Canada and the world at large involved a delay of weeks during the summer season and of months during the winter. Seven years ago the Department of the Interior, through its North-West Territories and Yukon Branch, took the first step towards bringing the north country closer to civilisation. With Edmonton as a base, a chain of wireless stations was built, which served Simpson on the Mackenzie River as well as Dawson and Mayo in the Yukon Territory. Since that year, the northern wireless system has been extended until to-day Fort Smith, Resolution, Simpson, Norman, Aklavik, and Herschel Island on the west, with Coppermine and Chesterfield Inlet to the east, are equipped with wireless offices, which handle ordinary commercial messages to and from all parts of the world. In addition, some of the more northerly offices are equipped with broadcasting plants, by means of which they are enabled to relay commercial messages and daily news bulletins to the more remote settlements.

SHANGHAI WATERWORKS

MR. C. D. PEARSON, M. INST. C.E., M.I. MECH. E., SHANGHAI, ENGINEER

(*For description see page 669.*)

FIG. 16—OIL ENGINE, AND MOTOR-DRIVEN SINGLE-STAGE MAIN PUMPS

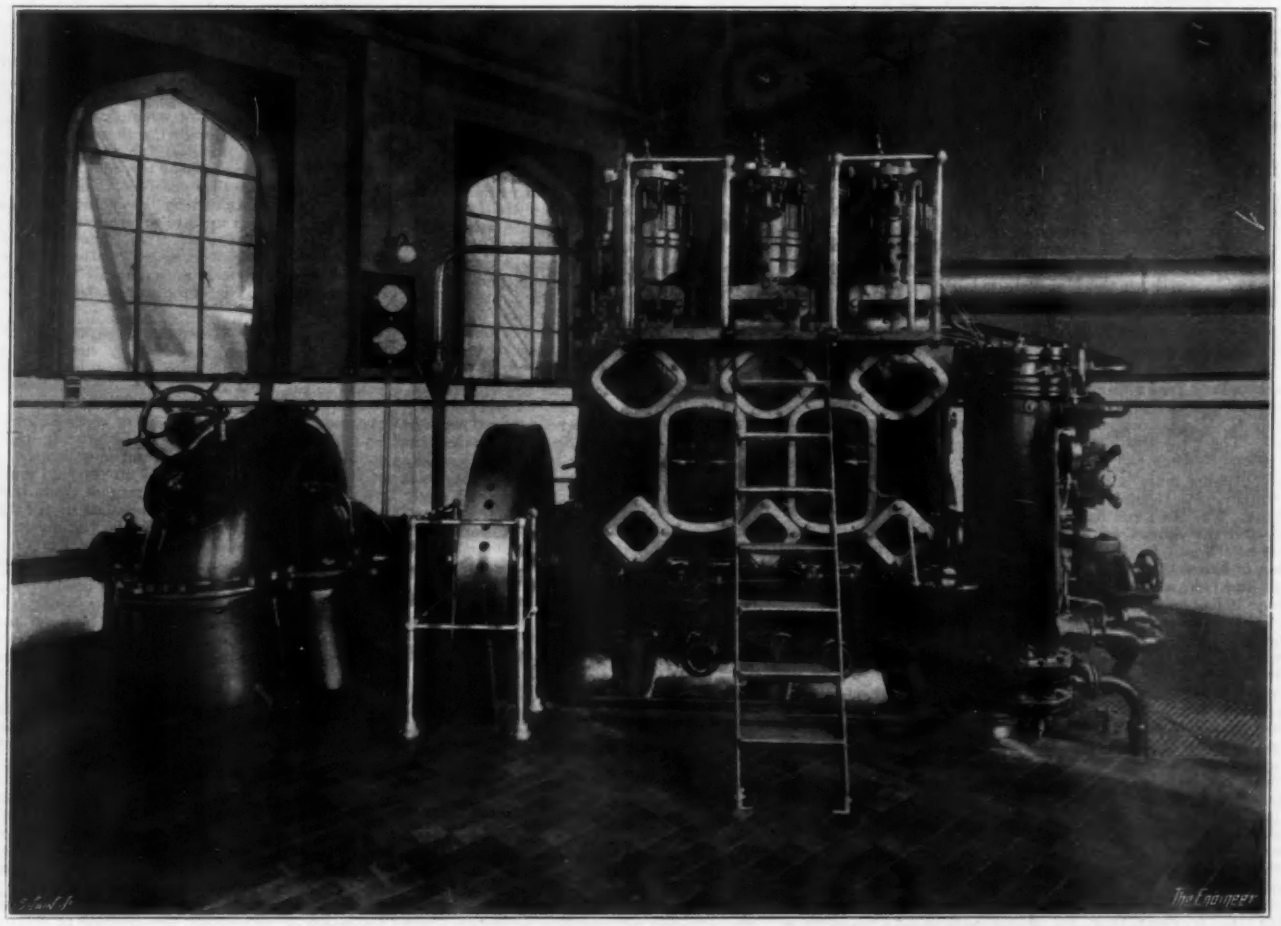


FIG. 17—TWO-CYCLE OIL ENGINE DRIVING LOW-LIFT CENTRIFUGAL PUMP

The Engineer

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SIXTEEN-PAGE SUPPLEMENT—"THE METALLURGIST"

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The Metallurgist.

THE DECEMBER NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

THE ENGINEER.

VOL. CLII. No. 3963

DECEMBER 25, 1931.

British Turbines on the Continent.

A FEW years ago the subject of British turbines on the Continent could hardly have furnished a theme except to historians and apologists. The former, moreover, would soon have come to a stop for want of material. Their story would have started bravely with the supply of two 1000-kW Parsons turbines to the city of Elberfeld in 1900, machines which were by far the largest in existence at the time and famous also for setting up a new record in efficiency. After so excellent a beginning little more would have remained to be said. The future of the steam turbine was then assured on the Continent and the market there for machines of the type in question was largely acquired by licencees and exploited by them. The lead given to British engineering by the success of the Elberfeld turbines was unhappily not followed up by any corresponding enterprise on the part of other British firms. Too many of the latter, indeed, gave a negative support to the engineering prestige of this country by their readiness to take up the manufacture, under licence, of almost any Continental design, in preference to developing types of their own. It is, in fact, possible to remember a time when hardly a single British turbine maker, outside Newcastle, was not building his machines under licence from some Continental firm or other. Hence, quite apart from any trading restrictions imposed by the granters of the licences, it was not to be expected that British built turbines in general would find much demand amongst Continental purchasers. The failure of our manufacturers to secure a continental trade in turbine machinery must, we fear, be largely attributed to their early lack of originality in design. Tariffs, of course, also hindered them, but tariff walls presented no greater obstacles to their trade than to the trade of the various continental nations amongst themselves. One could find Swiss, German, French and other name plates in abundance on turbines running far outside the frontiers of their countries of origin. Nor must undue weight be given to the generally lower manufacturing costs on the Continent, for British makers had always been well able to hold their own against their Continental rivals as regarded the supply of turbine machinery to other parts of the world.

Such was the state of affairs until recent years. Circumstances now have altered. Agreements have had time to lapse, licences to expire, and policies to be revised. The Elberfeld turbines had long to wait for any notable successors, but the lineage was revived in 1925 by a 20,000-kW turbo-generator supplied by Messrs. Parsons to the city of Rotterdam. Like its forerunner, this machine exceeded its guaranteed efficiency by a handsome margin, and the economy has been maintained every year since the set was started. Nor has the blading ever been touched during this period except for the fitting of anti-erosion shields to the final blade rows a couple of years ago. The reputation thus re-established for British machines on the Continent rendered it more easy for the same makers to obtain the order for two larger sets of 30,000 kW which were put into service a few months ago in the Velsen power station. Copenhagen, moreover, has followed the lead of Velsen by ordering the pair of units, each of 36,000 kW capacity, whose construction was referred to in our recent account of the activities of the Heaton Works. These instances are enough to show that British makers could compete successfully for Continental trade, even before the suspension of the gold standard rendered their products materially cheaper to most foreign buyers. But competition does not depend on price alone; the ability to offer something better than one's rivals is at least as important. It is doubtful whether we shall ever be able to sell turbines profitably in any market where cheapness is the only consideration. Nor is such trade of the kind most worth catering for, since mass production methods being inapplicable, cheapness can hardly be consistent with quality, and still less with leadership in design. The constant rise in steam pressures and temperatures and the rapid increase in the size of units demanded has created a market open only to those turbine makers who can supply something better to-day than was available yesterday. It is in this market that the greatest profits are to be earned. The key to it is leadership in design. The more difficult the problem, the fewer there will be who can tackle it, and the greater will be the prestige and the reward of those who can be entrusted with its solution. As regards the construction of turbines to work at the very highest pressures and temperatures, it must be admitted that the weight of experience at present lies with one or two Continental manufacturers, thanks mainly to the greater enterprise of certain foreign power station engineers. But it is equally true that the metallurgical problems involved have nowhere been so exhaustively studied as in this country, and nowhere else is there such reliable material available. Another feature of advanced modern practice is the reheating cycle, but here we have nothing to fear. One need go no farther than Barking to see a 40,000-kW turbine of purely British design which has been operating on this cycle for seven or eight years, with no trouble whatever. The new 50,000-kW Parsons machines for Dunston have also been designed for a re-superheating cycle, the partially spent steam being raised again to the very high temperature of 800 deg. Fah. before entering the low-pressure cylinder. There is, indeed, no feature in which Continental turbine design can claim any superiority over the best British practice, and it is doubtful whether an equally high and sustained efficiency or equal reliability in service is achieved even by the best known Continental makers. The secretiveness of Continental power station engineers with regard to operating data is in great contrast to the open publication which prevails in Great Britain, and tends to conceal both good and bad results indifferently. But where individual figures do come to light they do not support the view that Continental practice is in any way ahead of our own. The new units for Dunston, it will be remembered, are guaranteed, under penalty, to produce a kWh for a heat consumption not exceeding 9280 B.Th.U.—a figure which Continental manufacturers will find it difficult to challenge. It is true that some Continental turbines show a good thermodynamic efficiency, but that is a matter which does not concern the user in the least. It is the heat consumption per unit generated and not the thermodynamic efficiency which makes the difference in the coal bill.

A general survey of the situation seems to show no good reason why British turbine engineering should not enjoy a much more important place in

Continental countries than it has held in past years. At the moment the financial crisis has paralysed the development of electrical undertakings, but as soon as confidence is restored the projects now held in abeyance will be put into execution and a large amount of turbine machinery will necessarily be called for. There will still be tariff walls to be surmounted and often, also, financial interests to be negotiated, but the market will be there, and as recent experience has proved, it will be accessible to such British firms as can offer something superior to that attainable elsewhere. Thanks to the engineering initiative of the late Sir Charles Parsons and to the enterprise of Captain Donaldson, this country has established a lead of years over its continental rivals in the design and use of extra high-tension alternators, and has developed methods of construction which are not available to foreign makers. Again, the shielding of turbine blades against erosion, so as to prolong their life and the efficiency of the machine almost indefinitely, is another important invention peculiar to British turbines. In condenser practice, too, recent almost revolutionary changes in design have given a further lead to certain British makers. It is by technical advances such as these that markets are gained and held, provided always that they are exploited with adequate business enterprise. So far as turbine machinery is concerned, we can provide anything equal to, and much that is better than, the best of our foreign competitors, so that, in this branch of engineering, at any rate, there should be scope for the revival of exports which is now so urgently needed.

All the Colours of the Rainbow.

WONDERFUL as are the improvements in mechanism, in materials, and in efficiency for which the last three decades may justly claim the credit, we question if any of them are as remarkable and, in some senses, as beneficial as the changes which have taken place in factories in the same period. Those of us who are old enough to remember the conditions in engineering workshops at the end of last century, and have opportunities for contrasting them with those of to-day, are aware of the wonderful changes which have taken place in nearly every detail of factory construction and organisation. Thirty years ago only the most advanced thinkers had grasped the value of proper lighting; the methods of warming workshops was still but dimly understood, and the necessity for it barely appreciated; and the importance of cleanliness and order was barely known outside the pattern shop. Floors were ill kept, windows were never washed by anything more effective than rain, men warmed themselves by subornation of the smith, and general disorder in the shops was no more censured than similar disorder in the offices. We can still recall the surprise which a famous foreign machine tool factory aroused when it was visited by British engineers in the first year of the century, and the debates upon the necessity and value of the maple floors, the well-ordered benches, the standard painting of the machinery, the excellent lighting, the carefully devised sanitary arrangements, and the flowered surroundings of the offices and factory buildings, are fresh in our minds. What was rare then is common now. It is true that one may still find plenty of factories that smack of past ages, but it is only necessary to look at any of the buildings that are springing up in the new industrial South or to visit some of the new works or old works reformed, which are to be found in old industrial centres, to appreciate the greatness of the change which has taken place.

For its share in this improvement we must give due credit to the Welfare Movement and to the active organisation which represents it. But at the same time, we must not forget that managers in recent years have begun to take an interest in workshop psychology. Like all "ologies," it may readily be pressed too far, but there can, at least, be no doubt about the effect of a bad workshop environment upon the workers' mentality. The best work cannot be accomplished under bad, untidy and dirty conditions. We say this despite a great deal of diametrically opposite evidence. Exquisite work was, and is to this day, carried out in conditions of indescribable disorder. But it will be found, we think, that in such work individualism is predominant. Just as Dr. Johnson could do his finest work amongst a litter of books, papers, and bills, so the individual may be able to divorce himself from the conditions surrounding him, make a little oasis of cleanliness and precision, and produce work of the highest class. What is possible in the individual is not possible in the mass, and it has been found by experience, many times repeated, that only under the best conditions of lighting, heating, and organisation is the finest and most efficient repetition work produced. The recognition of the importance of environment has led to many strange experiments, but possibly the strangest of them all comes, as might be expected, from the New World. So far, it has not touched engineering, but Heaven alone knows if it may not come in time! We have seen engineering factories with flower parterres around them, and we have seen geraniums "all a-blowing and a-growing" in a famous boiler shop; who knows but that this latest Transatlantic experiment may spread through the Americas, and find at length a home in this older world. We quote from the report of a firm of American manufacturers of "high-grade shoes": "This concern, to maintain pay rolls, painted the machines, equipment, and inside of its plant, and used gay, bright, and, where moving machinery was concerned, contrasting colours. All the colours of the rainbow were used. Employees took pride in voluntarily keeping clean the machines, floors, and the immediate surroundings. The surprising result of this effort to provide work was that it became an important factor in the profitable operation of the business, because —(1) Eye strain was eliminated, resulting in (*a*) amount of rejected products and damaged materials reduced to an insignificant minimum; (*b*) older employees able to compete with younger hands and brighter eyes, both in quantity and quality of workmanship; (*c*) no reportable accidents for nine months. (2) Fatigue and nerve tension were eliminated. (3) *Morale* was improved; better attitude toward work, in keeping with the general brightness and cheer of surroundings. (4) The sales force has been affected by the high-quality spirit of the production department and has successfully sold this quality factor. (5) Of increased advertising by employees, visitors, and editors." If all this can be attained "by all the colours of the rainbow," the future of the paint-makers of the United Kingdom is assured. There are, no doubt, "brighter eyes" in "high-grade shoe" factories than are to be found in the drab realms of mechanical engineering, but, still, even in them, the reduction of rejects, the elimination of accidents, the expulsion of fatigue and nerve tension, the improvement of *morale*, the "high-quality spirit" in the sales department, and "increased advertising by employees, visitors, and editors" would be well won at the expense of half-a-dozen barrels of paints.

The spectrum, rather curtailed, is not a bad reflection of American mass psychology. It wants continual variety and movement. It likes the violent contrasts of jazz, and has no use for repose. The workshop colours appropriate to a nation still very young might be unsuitable for one that has reached a demure age. All the colours of the rainbow might not have the desired effect in Great Britain, but we have no doubt that some artist of the older school who would paint our factories in the tints and tones appropriate to an elderly civilisation could be found, and that by a proper and careful balancing of colours all the benefits which have accrued to the maker of "high-grade shoes" (U.S.A.) would be secured by the manufacturers of British water-tube boilers, alternators, motor cars, and steam turbines. For ourselves, however, we admit that it is not the actual colours but the spirit behind this effort which moves us. For practically one-third of their day the working man and woman have to pass their time in the surroundings connected with their business. The pleasanter those surroundings can be made, the happier will the people be, and the better will be the work they execute. Much is denied to the engineer; but much is allowed to him. He has already seen the evils of the old system. Has he explored the possibilities of the new to the full, or does the factory in all the colours of the rainbow open to him visions of still greater advancement in the provision for the welfare and happiness of his workpeople and the material benefits to industry which therefrom ensue?

Literature.

History of the Great Western Railway. Vol. II., 1863–1921. By E. T. MACDERMOT, M.A. London: Great Western Railway Company, Paddington Station. 1931. Price 10s. 6d.

WE have here a continuation of the history published in 1927, presented with the same degree of skill and wealth of detail as the two former parts, and about twice as thick.

The first three chapters give the history of the main Great Western line from 1863 to 1875. Everyone has heard of the final abolition of the broad gauge in May, 1892, when 177 miles were "narrowed" in two days. But it is not so generally realised how fast it had been melting away during the preceding quarter of a century. For example, in a single month, namely, May, 1872, no less than 295 miles were abolished. And between June 16th and July 4th, 1874, 208 more disappeared. The alteration was greatly facilitated by the longitudinal sleepers, because all that was necessary was to cut a piece out of the transoms, move one rail, and connect up again. In the case of transverse sleepers, it was much more difficult. An interesting illustration is given—on page 378—of a piece of broad gauge line on cross sleepers, near Exminster. One's own recollection of the broad gauge is that the running was exceptionally smooth. How far this was due to the longitudinal sleepers cannot be estimated. In giving evidence before the Gauge Commission in 1846, Vignoles, Cubitt, Gray, and Hawkshaw all said that engines were more prone to slip on longitudinal sleepers—the last two speaking of frosty weather.

In the early 'sixties there was a bad railway mania, which was more or less the cause of the Overend Gurney failure. The lines proposed at that time were purely speculative, without any question of local requirements, but started with the intention of blackmailing the existing railways into buying the owners off. The resulting financial position not only hampered progress, but caused acute monetary difficulties.

The succeeding chapters go back to early history, treating of the following lines, the dates at which they begin being given in parenthesis:—Monmouthshire (1792), Bristol and Exeter (1835), South Devon (1836), Cornwall (1835), West Cornwall (1825).

The Monmouthshire railways are very interesting. They were a collection of small tramways, and were combined into a railway in 1849–1855. Special wheels for the trucks, to run either on a 4ft. 4in. plate rail or a 4ft. 8½in. edge rail, and special rails with a broad foot on which the narrow flangeless wheels could run, were designed. "Ribbon" development, about which we hear so much nowadays, had occurred along the old tramways; in Newport the lines of tramroad had actually become the streets of the town, so that drastic alterations had to be made.

The Bristol and Exeter, always closely connected with the Great Western Railway, was swallowed up on January 1st, 1876.

The South Devon is famous for its disastrous experiments with the atmospheric principle. If one looks merely at the nature of the system, its failure seems only to be expected. But the fact that the breakdown should have been so complete, and should have come about so quickly, is less easy to understand, when one reflects that the Dublin and Dalkey line worked quite satisfactorily for twelve years, and was abandoned chiefly on account of the inconvenience of having an isolated portion in between two ordinary lines, a situation that arose when an extension was made. Furthermore, the system was worked with great regularity on the Paris and St. Germains Railway for six years, namely from 1847 to 1853, when the traffic became too heavy for it, and complete reconstruction would have been necessary. Even so, it struggled on until 1860, by which time locomotives were forthcoming which were capable of coping with the heavy gradients. The collapse here was partly caused by troubles with the stationary engines, which were not to be expected, and to the unfortunate delay in installing the telegraph, which made it necessary to work the pumps uselessly, sometimes for a long time, when the down trains were late. But the worst trouble of all was experienced with the longitudinal valve, which for some reason behaved much worse than in any of the other cases.

A chapter on the Cornwall Railway gives an account of the building of Brunel's celebrated Saltash Bridge, in which the thrust of arches is counteracted by the pull of chains, the only other example of this construction being the smaller one at Chepstow.

The story of the West Cornwall refers to Murdock and Trevithick having constructed the first English locomotives in that county, with a footnote "In 1784 and 1802 respectively." This note should have been amplified by the words: "the first being only a model"; since, as it stands, more credit appears to be given to Murdock than that to which he is entitled.

In Chapters IX. to XIII. we return to the Great Western proper, and find its history from 1875 down to 1921, the greatest work described being the building of the Severn Tunnel, 1883 to 1885.

The last three chapters deal with the Locomotive and Carriage Department. Mr. Ahrons' mantle has fallen upon Mr. A. C. W. Lowe, who has carried out this section ably.

Appendices consist of a table of dates of opening and mileage; lists of broad gauge engines; and dividends.

The quality of the book is fully equal to that of its predecessors, the only fault being the same, namely, that the page is so small that the illustrations are cramped, examination of most of the maps calling for a magnifying glass; otherwise the volume cannot be too highly commended.

HIGH-SPEED HEAVY-OIL ENGINES—TYPICAL FORMS OF COMBUSTION CHAMBER

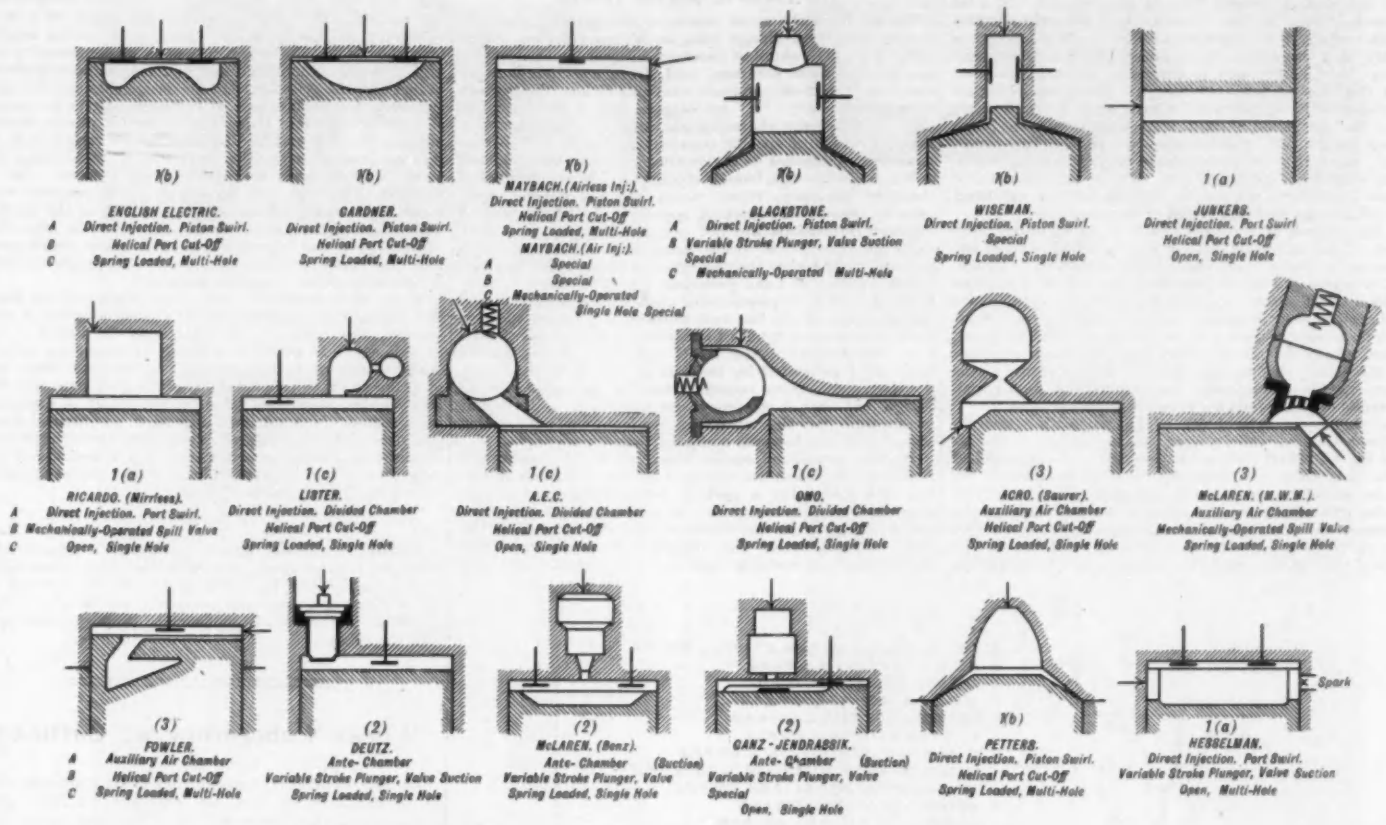


FIG. 8

Table Illustrating Present Designs of High-speed Heavy-Oil Engines.

Name.	Number of cylinders.	Bore.	Stroke.	Speed, r.p.m.	B.H.P.	Weight per B.H.P., lb.	Compression pressure, lb./sq. in.	Maximum pressure, lb./sq. in.	B.M.E.P., lb./sq. in.	Fuel pressure, lb./sq. in.	Fuel consumption, lb./B.H.P./hr.	Remarks.
English Electric ..	6	6in. 152·5 mm.	8in. 203 mm.	600 to 1500	200 at 1500	18	500	850	79	2500	0·39	—
Gardner	4	4½in. 114 mm.	6in. 152·5 mm.	1000	44	15	450	750	91·2	2000	0·38	—
Maybach—												
Airless injection ..	6	5·51in. 140 mm.	7·09in. 180 mm.	1300	150	13·8	500 to 570	780	88	—	0·40	Both types are also made with 12 cylinders.
Air injection ..	6	5·51in. 140 mm.	7·09in. 180 mm.	1400	175	13·2			100	—	0·47	The drawing in Fig. 8 shows the combustion chamber for air injection. Control by pump suction valve, and variable size orifice in fuel valve.
Blackstone	6	4½in. 117·5 mm.	6in. 152·5 mm.	1000 to 1500	55 to 97	15·75	420	600	86·5	1800	0·46	Also 2 and 4 cylinder engines. Blackstone spring injection.
Wiseman	4	4in. 102 mm.	6in. 152·5 mm.	800 to 1800	29 to 65	—	450	750	95	1500	0·42	Also 1 and 6-cylinder engines. Two-plunger "Verus" pump.
Junkers	2	3·15in. 80 mm.	11·8in. 300 mm.	1100	45	15·4	540	900	85·3	7000	0·43	Two-cycle opposed-piston engine
Ricardo (Mirrlees) ..	6	5½in. 143 mm.	6½in. 165 mm.	1200	132 (max.)	—	—	850	90·5	—	0·39	—
Lister	4	4½in. 114 mm.	5½in. 140 mm.	1000	45·2 (normal) 54·0 (max.)	53·0	450 (normal) 600 (at starting)	750	82	2000	0·43	Also 1 and 2-cylinder engines.
A.E.C.	6	4·53in. 115 mm.	5·59in. 142 mm.	1500	77·1 (normal) 130 (max.)	9·34	525	—	93·5 (max. B.H.P.	1000	0·43	—
Omo	6	4·33in. 110 mm.	6·30in. 160 mm.	1800 (normal)	130 at 2000	12	460	—	98 (max.)	2000	0·43	Air insulated hot body. Also other units of similar design.
Acro (Saurer)	6	4·33in. 110 mm.	5·91in. 150 mm.	1600	80	—	455	570	76	1150	0·45	—
McLaren (M.W.M.)	6	4·13in. 105 mm.	5·91in. 150 mm.	1400	74 to 88·7	13·6	512	—	87·8	1700	0·43	—
Fowler	6	4·72in. 120 mm.	7·08in. 180 mm.	1400	90	24·4	—	—	70 80 (max.)	2000	0·45	Also 2, 3, 4, and 5-cylinder engines. Auxiliary chamber connected by three holes to main chamber.
Deutz	6	4·72in. 120 mm.	6·70in. 170 mm.	1500	110	20·2	560	720 to 750	80	1080 to 1420	0·46	—
McLaren (Benz) ..	6	5·32in. 135 mm.	7·87in. 200 mm.	1000 (max.) 800 (normal)	90 to 120	32·7	500	750	85	1000	0·46	Also 2, 3, and 4-cylinder engines.
Ganz-Jendrassik ..	6	4·13in. 105 mm.	5·51in. 140 mm.	1650	72	18·7	427	498 to 570	77·1	2495	0·43	Also 6 and 8-cylinder engines of different cylinder dimensions.
Petters	3	4½in. 114 mm.	5½in. 137 mm.	1600	50	30	450	700	42	2100	0·48	Two-cycle, separate scavenging pump.
Hesselman	4	3·94in. 100 mm.	5·35in. 136 mm.	500 to 2500	20 to 50	—	114	425	102	—	0·47 to 0·65	Spark ignition. Low compression ratio.

Some Characteristics of High-speed Heavy-oil Engines.*

By S. J. DAVIES, Ph.D., M.Sc., M.I. Mech. E.

(Concluded from page 657.)

CONDITIONS OF SATISFACTORY PERFORMANCE.

ALTHOUGH there are many matters connected with oil engines yet to be investigated, there are, as a result of research work, on the one hand, and of experience in service, on the other, certain conditions which are recognised as associated with satisfactory performance. Further, it is understood that these conditions, in various degrees, concern: first, the form of the combustion chamber; secondly, the fuel injection system; and thirdly, the properties of the fuels used. Two practical demands are made to-day on oil engines for transport purposes: (*a*) that the exhaust shall be clear; and (*b*) that the running of the engine shall be sweet—that is, without that noise commonly and falsely known as "Diesel knock." In other words, the mixing of the fuel and air shall be carried out so as to give complete combustion in the cylinder, and the rate of rise of pressure during combustion shall be so controlled that the combustion noises are not objectionable. To give a clean exhaust, as well as to ensure good thermal efficiency, combustion must be reasonably complete early in the expansion stroke. It is also clear that satisfactory performance is facilitated when all three of these factors, combustion chamber, injection system, and fuel, are favourable towards a reduction of the "ignition lag"—that is, that interval of time which elapses between the instant of the fuel entering the cylinder and the beginning of the rise of pressure from the compression curve. This rise of pressure indicates that heat is being generated by combustion. It is not possible within the scope of this paper to discuss all three of these factors in detail. But it is of interest to consider briefly the interaction of each upon the other and to discuss the trend of present-day design.

FORMS OF COMBUSTION CHAMBER.

The extraordinary diversity in the forms of combustion chambers successfully used in high-speed oil engines is to be seen in the Table and Fig. 8, which include also the leading particulars of the designs given. It will be noticed that these designs are classified under three main types, briefly described as (1) "direct injection," (2) "ante-chamber," and (3) "auxiliary air chamber," and that the direct injection type has been further subdivided under the three headings: (*a*) Port swirl, (*b*) piston swirl, and (*c*) divided chamber. The details of many of these types have been treated elsewhere,[6] but some consideration of this classification is desirable in order that the general lines of development of oil engines may be discussed.

The distinguishing feature of the chambers of type (1)

* Institution of Mechanical Engineers, Midland Branch, Birmingham, Thursday, December 17th.

[6] British Association, Bristol, 1930, *Engineering*, October 24th, 1930.

is that the fuel is injected direct into the chambers in which combustion takes place, the subdivisions (*a*), (*b*) and (*c*) being necessary to indicate the three ways in which the air and fuel are brought into contact. In 1 (*a*) represented here by the Junkers and Ricardo-Mirrlees designs, the air, in its passage through the ports, acquires velocity and direction which determine its subsequent motion—in the two cases mentioned, tangential swirling about the axis of the cylinder. In the Ricardo design the jet is parallel to the cylinder axis, while in the Junkers engine the jet is fan-shaped, radial, and with its plane slightly inclined to the horizontal. In the Hesselman engine, which is a low-compression engine burning heavy oil and employing spark ignition, similar, but less definite motion is given to the air by shrouds on the overhead inlet valves, the jet being radial in this case also.

In the engines of type 1 (*b*), with "piston swirl," any motion of the air is set up by the combined form of the piston and cylinder head, during the compression stroke. In such engines as the English Electric, Gardner, and the Maybach with airless injection, in which the combustion chambers are very compact in form, this motion must be indefinite in character; in the Blackstone and Wiseman designs, where the air is forced from the main chamber into the head, the motion will be more definite; the Petters engine—incidentally, the only British high-speed, two-stroke engine—falls between these two groups.

The engines of type 1 (c), of Lister, A.E.C.-Ricardo, and Omo designs, while relying on the motion of the air set up by the piston during compression, are distinguished by the possession of a separate chamber into which the air is forced during compression, and within which injection and the greater part of the combustion takes place. In all three cases, the form of the passage between the two parts of the combustion chamber, combined with the spherical form of the separate chamber, exert a dominating influence upon the type of motion given to the air. The Omo engine is further distinguished by the employment of a bowl-shaped hot-body, partly heat-insulated from the walls, which serves to raise the temperature of the air more rapidly during compression. This class of engine, with a separate chamber, is the newest, and will be referred to more particularly later in the paper.

Engines of type (2), "ante-chamber engines," are distinguished by the fact that the combustion chamber is divided into two parts, the ante-chamber and the main chamber, separated by a constricted passage; further, that the fuel is injected into the ante-chamber and a part only of it is burnt there. The remainder, through the difference of pressure set up by the initial combustion in the ante-chamber, is forced at high velocity through the constricted passage into the main chamber where it mixes with the air and is burnt. The mixing is thus brought about by the indefinite turbulence, as distinct from definite swirling, caused by the violent passage into the main chamber of the partially burnt fuel.

Engines of type (3) are arranged with an "auxiliary air chamber," separated by a constricted opening from the main chamber, into which a considerable proportion of the induction air is forced during the compression stroke, and from which it streams at high velocity during the expansion stroke. Injection of the fuel is effected, not into this chamber, as in 1 (*c*), but towards the constricted opening, so that the velocity of the air passing from the auxiliary chamber plays a direct part in breaking up the fuel. Two new designs given in the table—the Maclaren-M.W.M. and the Fowler engines—and a further new design not given—the Lanova engine—emphasise the increasing attention being given to this type.

The only high-speed oil engine using air injection is that of the Maybach Company, which builds engines both with airless and with air injection. The air injection type has been standardised for use on the German State Railways. In this application the complication and weight resulting from air injection are relatively less important; moreover, compressed air plays a part in starting and reversing, the transmission gear being designed in accordance with these special circumstances. It is interesting to note that a new high-speed train, carrying about one hundred first and second-class passengers, and driven by Maybach oil engines, is projected for the Hamburg-Berlin service.

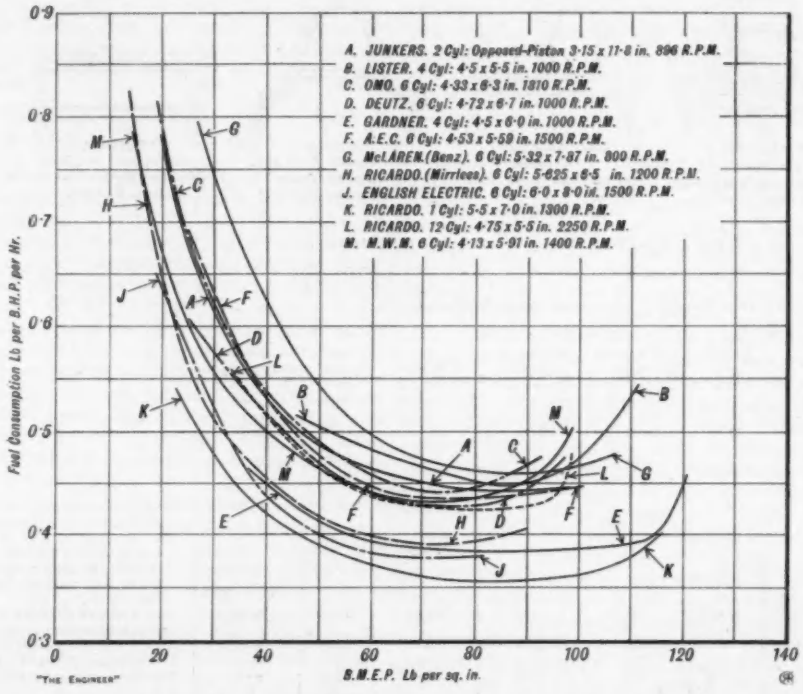

A. JUNKERS. 2 Cyl: Opposed-Piston 3·15 x 11·8 in. 896 R.P.M.
B. LISTER. 4 Cyl: 4·5 x 5·5 in. 1000 R.P.M.
C. OMO. 6 Cyl: 4·33 x 6·3 in. 1810 R.P.M.
D. DEUTZ. 6 Cyl: 4·72 x 6·7 in. 1000 R.P.M.
E. GARDNER. 4 Cyl: 4·5 x 6·0 in. 1000 R.P.M.
F. A.E.C. 6 Cyl: 4·53 x 5·59 in. 1500 R.P.M.
G. Mcl.AREN.(Benz). 6 Cyl: 5·32 x 7·87 in. 800 R.P.M.
H. RICARDO.(Mirrlees). 6 Cyl: 5·625 x 8·5 in. 1200 R.P.M.
J. ENGLISH ELECTRIC. 6 Cyl: 6·0 x 8·0 in. 1500 R.P.M.
K. RICARDO. 1 Cyl: 5·5 x 7·0 in. 1300 R.P.M.
L. RICARDO. 12 Cyl: 4·75 x 5·5 in. 2250 R.P.M.
M. M.W.M. 6 Cyl: 4·13 x 5·91 in. 1400 R.P.M.
Fuel Consumption Lb per B.H.P. per Hr.
0·9
0·8
0·7
0·6
0·5
0·4
0·3
0
20
40
60
80
100
120
140
B.M.E.P. Lb per sq. in.
"THE ENGINEER"

FIG. 9—CURVES OF SPECIFIC CONSUMPTION FOR VARIOUS ENGINES

THE TREND OF MODERN DESIGN.

It may be taken as an axiom of successful engineering design that, other things being equal, the simplest design is the best. The simplest combustion chamber is, it would appear, the most compact, and, from considerations of heat loss, the most compact form should give the highest thermal efficiency. To investigate this question, what may be called the characteristic curves of combustion—that is, curves of specific consumption on M.E.P.—from a number of engines of various designs have been plotted in Fig. 9. Although, from the point of view of combustion chamber efficiency, these curves are not strictly comparable, since differences of speed of revolution and of cylinder dimensions are not compensated for, it is clear from the curves that simple combustion chambers do, in general, yield higher thermal efficiencies, and also produce higher maximum mean pressures. But, in spite of these facts, it is also unquestionable that actual design of new engines, has, in the last two years or so, tended towards more complicated forms of chamber, such as those of type 1 (*c*), represented by the A.E.C. and Omo designs, and of type (3), represented by the Fowler and M.W.M. design. So that, both from considerations of the principles of design and also of efficiency and output, it is important to account for this apparent tendency of combustion chamber design towards complication.

It was mentioned earlier that, with the combustion chamber, the other two factors—the injection system and the fuel—also play a part in determining whether the running shall be satisfactory. It was also pointed out that for running to be satisfactory, not only must output and efficiency meet the desired standards, but that smoothness of running and a clean exhaust are also insisted upon; further, that satisfaction under the latter headings is only ensured when the ignition lag is sufficiently reduced to enable the rate of rise of pressure to be restricted within proper limits.

Experiments in engines, and in separate closed vessels, have shown that ignition lag decreases with rise of both pressure and temperature of the air into which injection takes place, and is influenced also by the relative motion of the air and fuel during injection. The rate of rise of pressure after combustion has begun is also strongly influenced, but in ways that are not easy to define, by this relative motion of air to fuel and by the losses to the walls. Thus, it would appear that the type of relative motion given by these more complicated forms of combustion chamber, together with the effects of these forms on the temperature and pressure of that part of the air into which the fuel is first injected, lead to conditions more favourable, from the point of view of practical performance—especially smoothness of running—than those given by compact chambers. It would also appear, though here the available data is not sufficient to be conclusive, that the "speed flexibility" of compact cylinders is less than those with complicated forms. The latter appear also to be less dependent upon the characteristics of the fuels used, and, in general, may burn fuels with a wider range of physical properties.

So far, in this paper, the effects of fuels and injection systems have not been dealt with, and it must be admitted that both of these factors have by no means been completely investigated. The various oil supply companies, with their excellent laboratory staffs and facilities, are naturally now devoting much attention to the fuel question, and there is reasonable hope that before long the properties, both physical and chemical, of heavy-oil fuels will be at least as well understood as those of light fuels for "carburettor" engines. The question of fuel injection systems is more closely an engineering one, and, in view of its basic importance, it may be said that the further evolution of high-speed oil engines depends more upon the advance of knowledge in this branch than in any other.

The problems of fuel injection gear as regards accuracy of manufacture are now too well recognised to need emphasis. That it has been possible for some years to purchase fuel pumps and nozzles as interchangeable accessories is an indication of the very high standard of precision of manufacture reached by more firms than one. Improvements even beyond this high standard are desirable and will, with increasing experience, undoubtedly be realised. The other problems are partly of a design character and partly in the direction of further research into the mechanics of the processes of compressing to a high pressure, conveying, and injecting minute quantities of fuel into the cylinder. On the design side, it is a healthy sign that the author has, in the past year or so, seen in this country no less than four designs of pumps working on principles which claim to give greater variation in, and greater control over, the injection characteristics than would appear possible with existing designs. On the research side, there are investigations in progress which must add greatly to our knowledge. It is the author's view that, given better knowledge of fuels and closer control over the injection process, future development may eventually be re-directed towards the simpler solutions of the combustion chamber problem.

There is, in conclusion, one other aspect of the future development of oil engines which should be borne in mind, namely, the influence of what may be called "mass experience." It would be difficult, in connection with the development of petrol engines, to separate those steps in progress due directly to the research engineer from those which have been taken as the result of experience in practice. Carburation, lubrication, mechanical design, practical upkeep, have all developed through practical experience. So far, the oil engine has lacked this "mass experience"; it is reasonable to expect further progress, if only as a direct result of this.

Finally, the author would express his thanks to those firms who have kindly supplied him with information; he would also like to thank Messrs. C. W. Lawson and H. C. Stevens, research students at King's College, London, for their kind assistance in preparing the figures and the table.

Works Laboratory at Cathcart.

On the occasion of a recent visit to the Cathcart Works of G. and J. Weir, Ltd., we inspected the firm's newly completed works laboratory, which has been designed and equipped to serve the control and research needs of the joint undertakings of G. and J. Weir, Ltd., Monel-Weir, Ltd., and the Argus Foundry, Ltd., and to deal with the many-sided problems of the varied industries with which these allied firms are connected. The first works laboratory at Cathcart was established some twenty years ago, and starting from very small beginnings, the department grew until new premises were urgently required. The accommodation chosen is in a building which at one time formed the head offices of the company, consisting of two main floors and a basement for storage about 45ft. square. The stairway is accomodated in a central well covered with a glass roof, and this, together with ample window area on all sides of the building, in combination with white walls and ceilings, has resulted in a very effective and uniform lighting, as will be seen from our illustrations on page 683. The building is heated by hot water radiators, and the floors throughout are covered with rubber, which, in addition to being pleasing in appearance, is comfortable for walking and makes for quietness.

In designing the laboratory careful consideration was given to the arrangement of the essential service supplies. These include both cold and hot water, coal gas, compressed air, and electric current at 240 volts A.C. and 120 volts D.C. The supplies to the ground floor rooms are brought from the basement, while those to the top floor rooms are housed in a trunk which runs round the walls at a height of about 2ft. above the floor level. Tappings from the various supplies are taken to the working benches, and ample provision, we noted, has been left for further tappings when such may be required.

The main switchboard is in the entrance hall and part of it can be seen through the partition shown to the right of Fig. 2. In addition to the 240-volt and 120-volt services already mentioned, there is a supply of 440 volts, three-phase current for motors on the ground floor. The ground floor contains three office rooms, besides the testing machine room and the pyrometry and furnace section.

In the machine room—see Fig. 1 on page 683—the principal item is a 50-ton "Olsen" machine for tensile and transverse testing. It is a motor-driven geared machine with an automatic balancing arrangement for the jockey weight, and with an autographic stress-strain recorder. A complete set of grips made in the works tool department is available for all sizes and shapes of test bars and also for complete turbine blade and other important sections. The accessories for the machine included, we noted, a Ewing extensometer and an Amsler standardising box.

From time to time high-temperature tensile tests are required to be carried out on this machine. These are made by heating the test pieces in an electric furnace, which surrounds the specimen, and tests have been made in this way at temperatures up to 1000 deg. Cent. The other machines in this room comprise a 120 foot-pound Izod impact machine, a Brinell hardness tester, a sclero-scope and an Erichsen ductility tester. A power hack saw and sensitive drill are furnished for the preparation of samples for analyses and for cutting sections, &c. One end of the machine room is allocated to condenser tube corrosion testing. These tests are carried out with actual sea water, and they comprise both simple aerated immersion tests and accelerated tests of the "jet impingement" type.

In the pyrometer testing and electric furnace room there are a number of electric furnaces for experimental heat treatment, some of which are shown in Fig. 2. In addition to the usual type of furnace which is wound with Nichrome wire, there are two new furnaces heated by a special type of resistance element which permits heating to temperatures over 1300 deg. Cent. The pyrometer section of the laboratory is responsible for the calibration and repair of the works pyrometer equipment, and for electrical testing there is a bridge megger, a ductor ohmmeter along with

NEW RESEARCH AND WORKS LABORATORY AT CATHCART

G. AND J. WEIR LTD., CATHCART, ENGINEERS

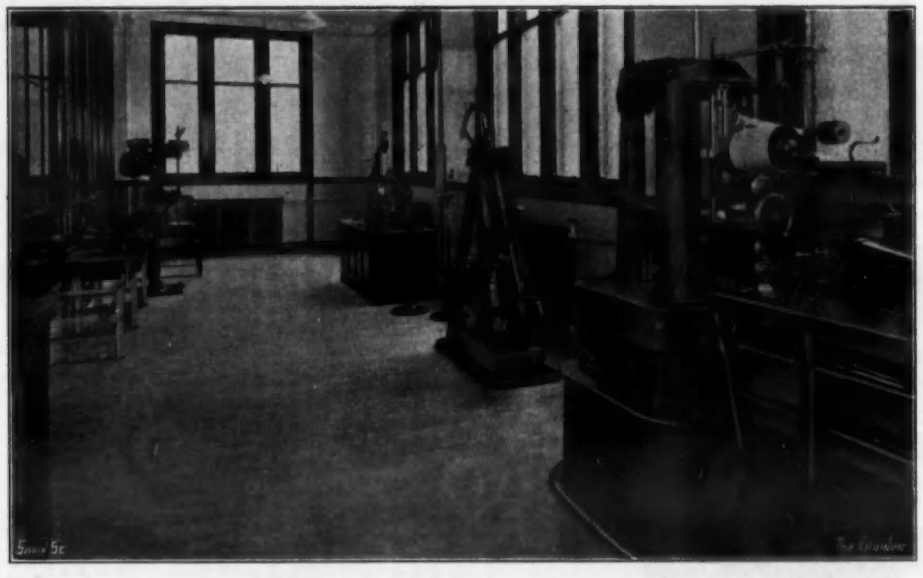


FIG. 1—TESTING MACHINE ROOM

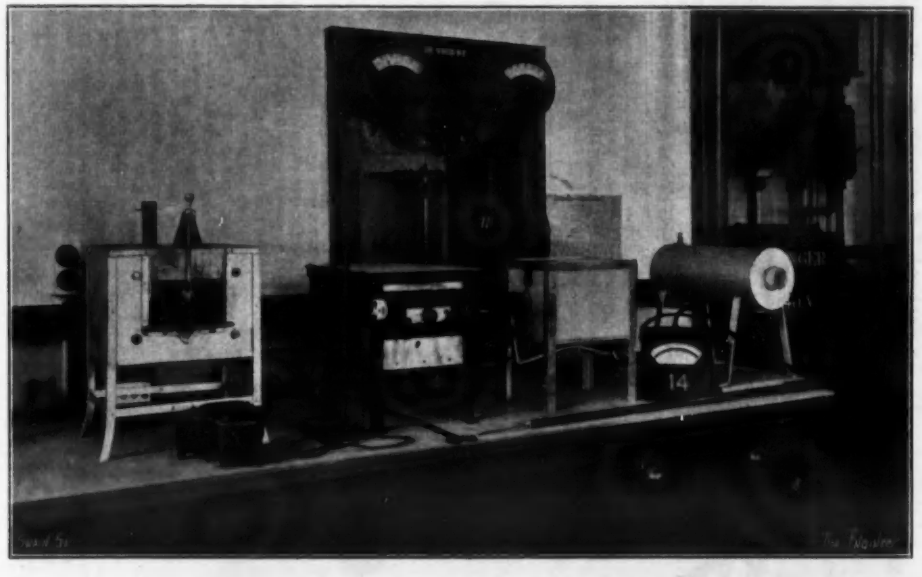


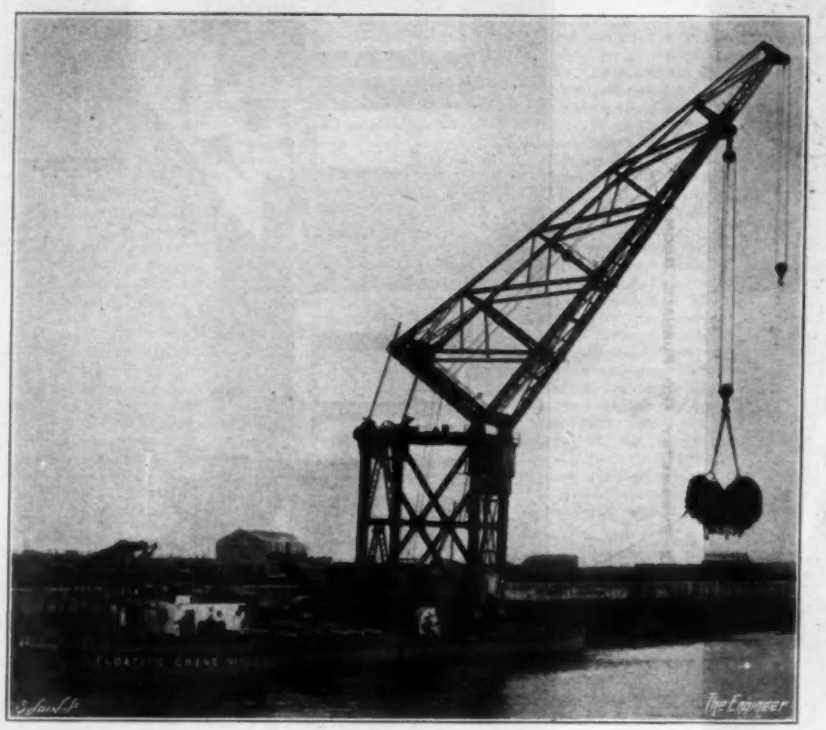
FIG. 2—PYROMETRY AND FURNACE ROOM

FIG. 3—CORNER OF METALLOGRAPHY ROOM

FIG. 4—PART OF CHEMICAL LABORATORY

60-TON FLOATING CRANE FOR CAPE TOWN

COWANS, SHELDON, AND CO., LTD., CARLISLE, ENGINEERS



standard millivoltmeter, multi-range voltmeters and ammeters.

The whole of the upper floor, with the exception of the metallographical section, is given over to the chemical laboratory, part of which is illustrated by Fig. 4. The walls, it may be noted, are tiled in white and the ceiling is painted with a white glossy acid-resisting paint. The benches are covered with white acid-resisting rubber, which gives a surface which, while it is easily kept clean, does not crack the hot beakers and greatly minimises breakage of glass. The titration bench seen to the right in Fig. 4 is covered with thick opal glass. All the sinks are made of acid-proof porcelain with open traps below, which lead into vitreous-lined waste pipes. Although corrosion-resisting materials and fittings have been chosen wherever possible, every effort has been made to prevent the fumes which are inevitable in chemical analyses from pervading the atmosphere. Two large fume cupboards are provided and these have been found to be effective in carrying away the fumes.

The balance room is arranged midway between the two main portions of the chemical laboratory, and the swing doors are fitted to the room for more easy entry and exit. The balances rest on a thick sheet of opal glass, under which there is a ½in. layer of sponge rubber. This precaution, we were informed, effectually prevents any vibration either from passing traffic or from the works adjoining from affecting the balances. An electric muffle is placed close to the balances so that ignited precipitates have not to be carried any distance. In the balance room the carbon combustion apparatus and the apparatus for electrolytic analyses of non-ferrous metals is also arranged, and includes nine sets of stationary platinum electrodes and one rotary set for rapid estimation, all designed for electrolytic analysis.

In the micrographic room—see Fig. 3—there is a Beck-Rosenhain metallurgical microscope complete with its camera, and the polishing machine for micro specimens is placed in this room, so that it is also handy when required for repolishing a specimen. Alongside the microscope room there is, we observed, a well-equipped dark room for the development of plates and prints.

Besides serving for works control and for dealing with the very wide range of subjects embraced by the firm's manufacturing experience, an effort has been made to set up a bureau of information on all these subjects, and the documentation has been conveniently arranged in card index form, which, with a good technical library, enables any particular question to be answered immediately. The research work on corrosion in boilers and in feed systems which was begun by the late Mr. James Weir has been greatly extended and has yielded, we understand, very useful results. Such work, along with that in the newer fields relating to high temperatures and pressures and the employment of the alloy metals of the Monel and malleable nickel groups, is being continuously carried out under the control of the laboratory we have described.

A 60-Ton Floating Crane for Cape Town.

IN the accompanying engraving we illustrate a 60-ton electrically-driven revolving floating crane which has been recently constructed by Cowans, Sheldon and Co., Ltd., of Carlisle, for the South African Railways and Harbours for use at Table Bay Harbour, Cape Town. The engraving shows the crane lifting its test load of 75 tons. It is of the slewing and derricking type, and is provided with two lifting blocks, one designed to handle loads up to 60 tons and the other loads of 20 tons. The 20-ton block slews at a maximum radius of 93ft. 6in. when the greatest height of lift above water level is 110ft., while the main block is arranged to lift loads of 60 tons at a maximum radius of 80ft. from the centre of rotation of the crane. The height of lift above water level for this load is 100ft. Hoisting speeds of 10ft. and 30ft. per minute are provided for the heavy and light loads respectively. Slewing through 360 deg. can be accomplished with a 60-ton load in three minutes, and the jib can derrick with its full load through the full range in about ten minutes.

All the crane movements are effected electrically, power being supplied by an oil engine-driven generator placed in the pontoon.

The controls are so designed that the various motions can all be worked by one man. As our illustration shows, the operator's cabin is situated on the upper part of the framework, from which point he has a clear view of the load as well as the pontoon deck. A special feature fitted on this crane is a safety device which is provided in order to prevent the possibility of overloading.

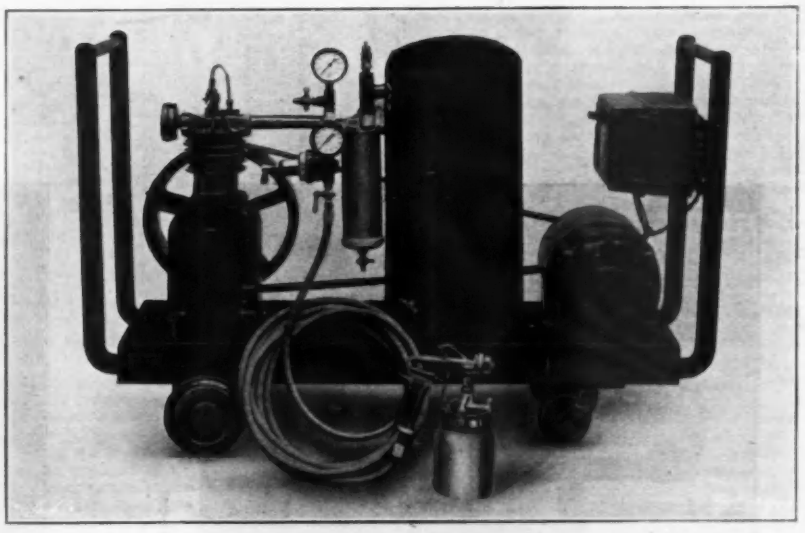
The pontoon, which was built by the Furness Shipbuilding Company, Ltd., of Haverton Hill-on-Tees, is of the non-propelled type, and has a length of 160ft., with a moulded beam of 56ft., and a moulded depth of 12ft. It was built to Lloyds A Class Special Survey for harbour service, and the shell scantling was increased above classification requirements in order to resist the heavy corrosion incidental to South African waters. The hull is divided into a number of compartments by longitudinal and transverse bulkheads, those beneath the crane being particularly designed to withstand the loads imposed. The deck amidships is specially reinforced and, as shown in the engraving, covered by a number of timber bearers for the purpose of receiving loads for transportation. The generating and auxiliary equipment includes a Robey-B.T.H. oil-engine-driven main generator set, and a Gardner-B.T.H. auxiliary set. An electrically-driven windlass by Clarke Chapman and Co., Ltd., of Gateshead, with extended working drums, is provided at each end of the vessel, which is provided with two anchors and cables, while other deck equipment includes the usual bollards and fair leads, &c. There is an accommodation compartment at each side of the vessel.

The structure shown at the left-hand end of the pontoon is a temporary trestle for carrying the jib during the voyage. It may be stated that, in addition to building the pontoon, the Furness Shipbuilding Company, Ltd., was also entrusted with the jib structure, as, at the time the order was placed, the structural department of Cowans, Sheldon and Co., Ltd., was more than fully employed. The designs were, however, supplied by Cowans, Sheldon and Co., Ltd. The crane is shown undergoing its full-load test at Haverton Hill-on-Tees. It left Middlesbrough on September 7th, and has now, we learn, safely accomplished the greater part of the voyage to Cape Town.

A Paint Spraying Plant.

THE illustration which we reproduce below represents a simple little arrangement of plant, by Delco-Remy and Hyatt, Ltd., 111, Grosvenor-road, London, S.W. 1, for supplying compressed air for paint-spraying and similar purposes.

It comprises a vertical, air-cooled, single-cylinder compressor, with a bore of 3in. and a stroke of 2¾in., which has a displacement of 5 cubic feet per minute. This compressor delivers at a pressure of 100 lb. per square inch, and is fitted with an automatic unloader, which opens the valves at that pressure and cuts in again after a drop in pressure of about 20 lb. per square inch. It is driven by a 1 B.H.P. electric motor, which is fitted with a semi-enclosed, or ironclad, switch and starter. If it is desired, the starter can be connected up with a relay so that the motor is stopped and started automatically, according to the demand for air, instead of running light, as is the case with the unloader. The compressor delivers into a receiver of about 1 cubic foot capacity, from which the air is drawn through a separate oil and water trap. This trap is fitted with a drain, a pressure gauge, and a connection for taking off full pressure air for any service that may be desired, such as blowing up pneumatic tires. Air for paint spraying is passed through a reducing valve, which can be adjusted to suit the immediate requirements, and is equipped with a gauge on the low-pressure side. The plant is appropriate for use with a quart size paint gun, or with a container sprayer, with two lines of hose of up to 12 gallons capacity.



PAINT SPRAYING PLANT

CALENDARS, DIARIES, &c.

AITON AND CO., Ltd., Derby.—Wall calendar with monthly tear-off sheets.

BAIRD AND SON, Ltd., Temple Ironworks, Anniesland, Glasgow.—Wall calendar with monthly tear-off sheets.

T. BOLTON AND SONS, Ltd., Widnes, Lancs.—Pocket diary.

BRAITHWAITE AND CO. (ENGINEERS), Ltd., Broadway Buildings, S.W. 1.—Pocket diary.

BRITISH OXYGEN COMPANY, Ltd., Edmonton Works, London.—Calendar and engagement pad.

COUNTY OF LONDON ELECTRIC SUPPLY COMPANY, Ltd., New Broad-street, E.C. 2.—Telephone card.

DEXINE, Ltd., Stratford, London.—Wall calendar with monthly tear-off sheets.

GREENWOOD AND BATLEY, Ltd., Albion Works, Leeds.—Wall calendar with monthly tear-off sheets.

R. AND W. HAWTHORN, LESLIE AND CO., Ltd., Newcastle-upon-Tyne.—Wall calendar with monthly tear-off slips.

HOLMAN BROTHERS, Ltd., Camborne, Cornwall.—Wall calendar with monthly tear-off slips.

REASON MANUFACTURING COMPANY, Ltd., Brighton.—Greeting card.

SIMPLEX CONDUITS, Ltd., Garrison-lane, Birmingham.—Pocket diary.

South African Engineering Notes.

Large Glass Works.

THE factory of the Union Glass Company, Ltd., at Talana, near Dundee, one of the largest and most interesting concerns in the Union, has just been reopened after a period of three months, during which all the machines were overhauled and the kilns completely rebuilt. There are some hundreds employed at the works, which are operated night and day. The power plant at the factory is larger than that used to light the whole of the town of Dundee, Natal, and burns 1500 tons per month.

Buffalo River Bridge.

After nearly a quarter of a century's service, the railway bridge across the Buffalo River at East London is to be replaced by a modern structure, which will provide for both rail and road traffic to be in operation simultaneously. The advance of East London as one of the Union's leading ports had made this bridge as much a necessity as the making of the turning basin for vessels in the river, now nearing completion. The existing timber bridge was constructed in 1908 at a cost of £19,858, and provides for both road and rail traffic. Whilst it has adequately satisfied the needs of railway traffic between East London and West Bank, its inability to cope with the ever-increasing road traffic has been the cause of congestion at either end of the structure, owing to its width being insufficient to allow of road and rail traffic operating side by side. Owing to its unsuitability and to the cost of its maintenance having increased with advancing age, it has become imperative to consider the provision of a permanent steel structure, capable of handling separately modern road and rail traffic. Sanction has been received for the construction of a combined road and rail bridge, the work of which will shortly be commenced. The roadway is to be directly above the railway, and there are to be nine road spans of 55ft. each, supported on steel columns, five rail spans of 55ft. each on concrete piers, and three main combined road and rail spans of 100ft. each, which will be supported by concrete piers carried on 14ft. diameter concrete cylinders sunk to rock, a maximum depth of 110ft. below low-water level. The overall length of the bridge from abutment to abutment will be just short of 1000ft., its height from rail level to low water level 35ft., while the roadway level is to be 22ft. above the rail level. The width of the roadway between kerbs will be 22ft., with 4ft. wide footways on each side. The weight of steelwork to be used is 1790 tons, and the estimated cost is £114,834, which sum will include the new approach.

Railway Extensions.

The Greytown-Rietolei Railway line has recently been opened in Natal, and it marks the completion of the programme of new works authorised in 1925. Work was begun on the new line, which is just under 25½ miles in length, exclusive of sidings, on November 28th, 1929. The track has been laid throughout with second-hand 80 lb. B.S.S. rails on steel sleepers, and has a ruling gradient of 1 in 50 compensated, while the sharpest curve has a radius of 7½ chains. A start has been made with the construction of a deviation between Kleinstraat and Matroosberg, on the Cape Western main line, its object being to reduce the heavy gradients which at present exist between these two stations. This line will permit of goods and passenger trains conveying the scheduled maximum through roads between Touws River and Cape Town without the necessity for banking or assisting engines between Kleinstraat and Matroosberg, and will result in important operating economies being effected and in greater all-round flexibility in handling the train service over this mountainous and difficult section of the Cape Western main line. Ever since the date of Union the Railway Administration has devoted considerable attention to the improvement and relaying of the track with a view to the working of heavier loads and a general acceleration of services. Among the most recent operations in this connection is the surveying of a new deviation from Alicedale to Mimosa, on the Port Elizabeth main line. The work of staking out the deviation is now almost complete and arrangements are being made for the initiation of the construction work which has been necessitated in the interests of economy and efficiency. The total length of the deviation will be 20½ miles. This will provide for a 1 in 80 (compensated) gradient in place of the old gradients of 1 in 40, which necessitated a very limited carrying capacity. The new deviation will permit of a goods train load of 900 tons being worked over the section, where at present the load is limited to 450 tons, while all services, both passenger and goods, will be accelerated in both directions.

Large Crane for Durban.

An 80-ton crane is to be installed at Durban in April next year. It is intended to deal with heavy lifts from steamers. Special foundations will have to be prepared to take the big load. The depth of water at the part where the crane will operate is 30ft., so that the biggest vessels visiting the port will be able to go alongside it. It was stated recently that heavy lifts had been deflected from Durban to Lourenço Marques, because of the poor facilities at Durban. In the next few months especially heavy lifts will arrive with the importation of machinery for the Union Iron and Steel Works.

Russian Petrol.

Probably the biggest, certainly one of the biggest, shipments of Russian petrol to this country recently arrived in the tanker "Atilla," which concluded discharging her cargo in the middle of November. The vessel brought 11,900 tons, of which three-quarters were discharged at Durban and the remainder at East London. The "Atilla" is the first ship with Russian petrol to discharge under the agency of C. G. Smith and Co., the makers of the Union spirit, in which Russian petrol is blended with alcohol. At the present time, and for some time past, the retail price of Russian petrol has been steadily maintained at 2d. per gallon below that of other petrol whether prices are reduced or put up.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Christmas Intervenes.

THE approach of Christmas generally brings about a flatness of trade, and this year has proved no exception to the rule. During the past fortnight, though there has been increased activity at some of the works owing to their desire to clear the works ready for stock-taking, &c., trade itself has slowed down and no marked change can be expected before the New Year. Very few of the Midland and Staffordshire heavy manufacturing works have any considerable carry-over of orders with which to resume operations, and industrialists generally are anxious to get new orders, or specifications against existing contracts, with which to make a start in January. Heavy engineers are very badly in need of new business, some of the basic industries are also very poorly supplied with orders. Midland blast-furnacemen have fairly healthy order books, which are made up of contracts extending in some cases to the end of the first quarter of 1932. A number of light engineering firms have a fair demand for special lines, while the lighter metal manufacturers of Birmingham and the Black Country finish up the year in a reasonably satisfactory state. With expenditure generally repressed trade omens are none too bright. Consumptive requirements both on home and foreign accounts are steadily improving, however, and though it is agreed that the New Year is likely to be a difficult one to negotiate hopes are expressed that the recent industrial progress will continue and that headway will be made even in the first quarter. Iron and steel market activites this week have been negligible and the weekly meeting of the Midland iron trade, falling as it did on Christmas eve, had only a small attendance. Values of material were not tested by the business on offer, and quotations remain at last week's level.

Cunarder Decision and Midlands.

Midland, and especially Birmingham, manufacturers are closely following the efforts being made to bring about a resumption of work upon the new Cunard liner, and are hoping they will meet with success. It is felt that holding up of subsidiary contracts will be a severe blow to the Midlands, for there is little doubt but that considerable orders would a little later have come to firms in this area had building been proceeded with. It is, indeed, reported that more than one order was on the point of being confirmed when work was suspended. Several Midland firms are already directly concerned, one having been engaged for some little time past upon dynamo sets for lighting the ship, and another in making the main boiler generator and air heater tubes, weighing over 1100 tons and measuring 235 miles. Orders which were expected to reach this district next year include those for such goods as ships' berths, ropes, electrical fittings, cabinet goods, electro-plate, &c. It is greatly to be hoped that it may be found possible to go on with the building of the liner.

Electrical Contracts for Midlands.

Two important contracts for electrical equipment recently placed have been awarded to Midland manufacturers. The British Thomson-Houston Company, Ltd., of Rugby, have received an order valued at £333,424, for transformers, switchgear and oil-filtration plant for the India Store Department, and the General Electric Company, Ltd., of Witton, Birmingham, for electrical equipment, including traction motors and apparatus for thirty-one new coaches required for the augmentation of the London, Midland and Scottish Railway electrical services.

Another Russian Order.

The Rees Roturbo Manufacturing Company, Ltd., hydraulic engineers, of Wolverhampton, have received from Arcos, Ltd., on behalf of the Russian Government, a substantial contract for the supply of machinery. It is roughly estimated that the new contract will keep about fifty men busy for four months. Contracts for pumping machinery for Russia, noted in this column three weeks ago, were placed with another Wolverhampton firm recently. The Rees Roturbo Company, it is of interest to note, has also on hand an important contract for machinery for King's Lynn waterworks.

Proposed Merger in the Tube Industry.

Important proposals for co-operation in the tube industry are at date under consideration. The directors of Stewarts and Lloyds, Ltd., have made an offer to acquire the shares of the Scottish Tube Company, Ltd., on the basis of one Stewarts and Lloyds 5 per cent. cumulative preference share for each similar share of the Scottish Tube Company, and five deferred shares of £1 each for each six £1 ordinary shares of the Scottish Tube Company. The offer is conditional upon 90 per cent. of Scottish Tube Company shareholders of each class accepting, or upon not less than 75 per cent. accepting and taking steps to put the Scottish Tube Company into voluntary liquidation and approving of an agreement providing for the purchase by Stewarts and Lloyds of the assets of the Scottish Tube Company in terms of the provisional agreement.

High-speed Diesel Engines.

An instructive address on "Recent Developments in High-speed Diesel Engines" was given last week by Dr. S. J. Davies to a large gathering of members of the Midland branch of the Institution of Mechanical Engineers at Birmingham. He dealt with the present trend of developments in the high-speed heavy-oil engine, particularly in its application to motor transport. Dr. Davies expressed the view that the high-speed heavy-oil engine has a big future, particularly in the field of transport. A vote of thanks to the lecturer was proposed by Sir Lincoln Tangye, Bart. Mr. W. B. Challen occupied the chair.

Steel Prices Reaffirmed.

The reaffirming last week of finished steel prices by the Steelmasters' Association had no appreciable effect upon business. It had been known that for some time past some steelmasters had been agitating for better selling terms, and in certain circles the view was held that there was a possibility of their claims being acceded to. The market generally held that as business was notably bad, steelmasters would have been ill-advised to make an advance in selling rates. So, once again, the majority of steelmasters dismissed the claim, which must almost certainly have been put forward and decided to try and induce business by keeping values down. The rebate rates were also reaffirmed. Angles are £8 7s. 6d., less 15s. rebate; tees, £9 7s. 6d., less 15s.; joists, £8 15s. less 22s. 6d.; ship, bridge and tank plates, £8 17s. 6d., less 15s. rebate. Boiler plates, which do not come in the controlled list, are quoted £8 12s. 6d. The flow of orders to the steel works is on a small scale, necessitating short-time working at practically all of the local establishments. Demand for structural steel is slow. In the half-products branches of the steel trade values are unaltered, except that continental shippers are offering supplies at lower rates in sympathy with the appreciation of sterling. Billets have been bought at prices varying from £4 10s. to £4 12s. 6d. There is no evidence of local works having bought heavily. On the contrary, there is very little inquiry circulating. It is some considerable time, however, since there was so narrow a margin between the prices of English and foreign semis. Native billets are firm at £5 7s. 6d., and re-rolled bars can be had at £6 17s. 6d. upwards.

Pig Iron.

Midland producers of pig iron have further improved their position and they end the year with considerable contracts on their books. Throughout the major portion of the year users have bought only for immediate requirements, but during the past few weeks they have entered into forward contracts some of which extend to the end of March next. There is a prevailing impression that raw iron prices are likely to advance, and consumers have judged it wise to cover themselves for some time ahead. It is said that blast-furnacemen could have secured much more business had they been so disposed, but, though they were prepared to cover themselves to the extent of their current rate of production, they would not go beyond this. They have held for some time now that with fuel prices appreciating their margin of profit, if they accepted contracts at current rates, would be very small indeed, and even with present production costs there was only a moderate return for their labours. Fortunately, for furnacemen, coke prices have not advanced as they threatened to do a month or so ago, and they stand at 12s. 6d. to 13s. per ton at ovens. Moreover, many Derbyshire and Northamptonshire smelters took the opportunity of securing forward supplies before the market advanced. Current demand for foundry pig iron is about on a par with production, but there are still stocks at the furnaces to be disposed of. Derbyshire and North Staffordshire No. 3 foundry pig is maintained at £3 6s. per ton, and Northamptonshire at £3 2s. 6d. Forge grades are 5s. per ton less in each case. Quotations are for delivery to Black Country stations.

Finished Iron.

Production of finished iron in Staffordshire has fallen away further this month, and at date works are short of specifications in all departments. The bi-monthly ascertainment of the Midland Iron and Steel Wages Board shows that output in September and October was heavier than in the two previous months and the largest recorded this year. The increase was mainly in bar iron. The average net selling price, however, dropped by 2s. 6d. Present quotations are unchanged at £12 for marked bars; £9 5s. to £9 15s. for Crown iron, £8 7s. 6d. for nut and bolt bars, and £10 10s. to £10 12s. 6d. for strip.

Galvanised Sheets.

Galvanised sheet prices are upheld at the improved basis figure quoted last week, namely, £9 5s. per ton for 24-gauge corrugateds. Demand has improved slightly and mills are better placed for business. The export figures for last month are not, however, encouraging, and rollers are none too sanguine as to the December returns. The home demand remains firm and reasonably heavy.

The Late Mr. Malpas.

After an illness extending over six months, Mr. Sidney Arthur Malpas died recently at his home at Handsworth. For over thirty-four years he had been connected with George Salter and Co., Ltd., manufacturers of springs, weighing machines, &c., of West Bromwich.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Liverpool or Manchester?

IT is known definitely that the National Gas Council proposes to establish in Lancashire one of the eleven research stations that eventually will span the country in the collective interests of the gas industry. At the moment, however, it is not known which of the two great Lancashire cities—Liverpool or Manchester—will be selected to house this new development, though Manchester interests appear to be reasonably confident that theirs will prove to be the favoured city. There is certainly some ground for this opinion. For example, the nucleus of such a station is already in existence, for

quite recently, in its own interests, the Manchester Corporation gas department opened a well-equipped and well-staffed workshop for the benefit of industrial users and potential users of gas. Here special and diverse problems are being submitted for solution, and a highly rained technical staff carries out the research and experimental work by means of which valuable data bearing on industrial operations which involve the use of the town's gas are supplied. Whether it is established at Liverpool or Manchester, the expectation is that the new research station will be opened early next year.

An Electrical Engineer for Stockport.

A controversy between two professional bodies and the Stockport Corporation Electricity Committee has arisen out of the vacancy for the position of borough electrical engineer at Stockport. The salary offered in connection with the post is £900 a year, rising to £1000, but the Electrical Power Engineers' Association and the Association of Municipal Electrical Engineers have both asked their members to refrain from applying for the position, their contention being that the scale for Stockport, based on output, should be £1800 a year, less 20 per cent. for a commencing salary. The situation at the moment is that the Electricity Committee has decided to ignore the action of the two professional associations.

Selling an Ironworks.

The Vice-Chancellor, Sir G. Courthope Wilson, K.C., in the Manchester Chancery Court on Monday of this week appointed Mr. W. C. Bolton, chartered accountant, Manchester, receiver and manager of Galloways, Ltd., Knott Mill Ironworks, Manchester. On behalf of William Deacon's Bank, Ltd., Manchester, trustees for debenture stock holders, it was stated that it was necessary to make the appointment with a view to a sale of the undertaking and assets as a going concern.

Non-ferrous Metals.

A good deal more activity has been in evidence in the copper and tin sections of the non-ferrous metals market during the past week. This has been largely the consequence of developments which were definitely "bullish" in nature, and which were soon reflected in an upward movement of both metals. Not only has copper recovered the ground lost in the previous week, but it has also established a substantial net gain, values at the moment of writing being about £3 10s. a ton above those ruling for standard metal a week ago. The rise has occurred following the news that agreement has been reached among the principal producers on the questions of output curtailment and marketing. Much freer buying has been experienced, not only in the United States but also in this country and on the Continent. A better trade demand for tin and the announcement of tighter control of stocks in relation to selling prices have been features of this section of the market during the past week. After being more or less stationary in the two previous weeks, English metal quotations have registered an advance of about £4 10s. a ton. The movement of lead has been somewhat restricted, and in spite of being 10s. up on balance for the week, values are still 5s. below where they were a fortnight ago. Spelter also is dearer by nearly 15s. a ton, largely in sympathy with the other metals, but business in this section has been on relatively quiet lines.

Iron and Steel.

The iron and steel markets have been rather listless, and movement will probably be lacking until after the holidays. Delivery suspensions have become almost general in virtually every branch, whilst new business during the past few days has been markedly absent. Pig iron makers offering in Lancashire are not sanguine at the moment of operations at the consuming end expanding much above the level that existed before the seasonal slackness set in, and there seems to be a disposition to expect that those users who have not covered their requirements over the early months of the year—principally those who have failed to take the full quantities of iron that they had contracted for up to the end of December—will revert to the more or less hand-to-mouth scale of buying operations that was in vogue three or four months ago. At the same time, sellers are hopeful that the slight improvement that has recently been reported in textile engineering, the light castings trade, and one or two specialised branches will be maintained in the New Year. Quotations keep up at 67s. per ton, delivered equal to Manchester, for Derbyshire, Staffordshire, and Cleveland No. 3, 65s. 6d. for Northants, about 87s. for Scotch, and 81s. for West Coast hematite. For the moment, the demand for bar iron has died away, but prices are steady at £9 15s. per ton for Lancashire Crown quality bars, and £8 5s. for seconds. Steel business is virtually at a standstill, and with continued poor order books among the majority of the heavy users in the Lancashire district, prospects of better things on the resumption are not promising.

BARROW-IN-FURNESS.

Hematite.

There is nothing favourable to report about the hematite pig iron trade at present, and until the holidays are over there will be little business done. The general tone is very flat, and it is not anticipated that the New Year will bring much improvement. There has got to be a world recovery before North-West Coast pig iron finds an active market. Continental and American requirements are very small. Stocks in the district still stand at a substantial tonnage. The iron ore trade is quiet, both as regards native sorts and foreign imports from Spain, &c. There is nothing fresh to report in regard to the steel trade, which, like iron, is experiencing a poor market. The holidays at Vickers-Armstrongs Naval Construction Works are short this year. For one thing work on the new Furness-Withy boat has got to be pushed on. She has got to be out in about fourteen months from now.

SHEFFIELD.

(From our own Correspondent.)

Holidays and Trade.

IF evidence is needed that conditions in the iron and steel industries of the Sheffield district are far from satisfactory it is to be found in the fact that most of the big works are closed for extended Christmas holidays. Conditions, as a matter of fact, are by no means satisfactory in either the heavy or the light branches of local industry, and at the close of the year it is difficult to be optimistic. Fluctuations in the exchanges and doubts as to the Government's intentions in regard to tariffs on iron and steel have had an adverse effect on all the buying markets, and until such difficulties are settled there is little likelihood of any substantial revival in trade. There was some extra activity, in completing orders, just before the holidays commenced, and there are one or two bright spots to be found in the general dullness. For instance, the output of stainless steel continues on a substantial basis. There are inquiries which may lead to greater use of this stainless metal in aircraft construction; whilst, as a contrast, it may be stated that considerable quantities of stainless steel road studs are being made in the city.

Railway Materials.

The railway steel departments are still extremely depressed. Home railway companies have been exercising such strict economy for a considerable time past, however, that it is confidently felt there can be little further delay before substantial renewals must be ordered. Stocks have been "starved," and it is hoped there will be increased orders in the New Year. On the other hand, it is not expected that much work will come to Sheffield in connection with the expenditure of the Boxer indemnity fund. Last month 7000 tons of rails were shipped to South Africa.

Exports Statistics.

The increase in the exports of iron and steel and their manufactures last month amounted to 35,000 tons, compared with the total for the previous month. Principally the increases were in plates, sheets, tubes and wire; tool and other alloy steels decreased considerably. The general total of exported steel was nearly equal to that of November last year, but only about half the total for the corresponding period of 1929.

Government Contracts.

Several contracts have just been obtained from Government Departments by local firms. Pig iron is to be supplied by the Staveley Coal and Iron Company, Ltd., Chesterfield, and hack saw blades by A. Balfour and Co., Ltd., Sheffield, to the Contract and Purchase Department. Boiler and ships' plates are to be made by the Park Gate Iron and Steel Company, Rotherham, and torpedo tools by F. G. Pearson and Co., Ltd., Sheffield. Mild steel is to be supplied to the War Office by the Steel, Peech and Tozer branch of the United Steel Company, Ltd., Sheffield. To the Crown Agents for the Colonies tubes are to be supplied by Howell and Co., Ltd., Sheffield, and for H.M. Office of Works steel work is to be made by W. H. Blake and Co., Ltd., Sheffield, and rails by Markham and Co., Ltd., Chesterfield.

Scunthorpe Iron Order.

Negotiations with an American firm for a substantial sale of iron have been completed by the Normanby Park Steel Works, Scunthorpe. Prior to some two years ago these works had sold considerable quantities of iron to America, over a period of eight or nine years, but owing to the depressed condition of the industry they have been unable to effect any exports for the last two years. As a result of the order just secured the output of one blast-furnace for several months in the New Year will be absorbed, and it is expected that employment will be found for a number of additional men. This is a welcome sign of improvement in trade in the Scunthorpe area.

Steel Testing Apparatus.

The claim that a great deal of laborious analytical work may be rendered unnecessary is made on behalf of a new apparatus for testing steel which has been installed at the works of Darwins, Ltd., Sheffield. This apparatus can test steel or iron bars of any thickness up to 4in. The bars are passed through magnetic coils, with the result that a fine wave of light is seen on the ground glass screen of an oscillograph. Any fault or variation in the material being tested causes an instantaneous deflection in the light wave. Internal defects can be detected as easily as those on the surface of the metal, which, it is claimed, is not injured in any way. The testing is both accurate and rapid, allowing a large quantity of material to be tested at reasonable cost, instead of one piece out of a large quantity as under the present method. The services of experts are not required, and the equipment is semi-automatic. The apparatus will be specially valuable to manufacturers of razor blades, high-speed steel, stock bars, and magnetically welded tubes. The machine at the Darwins works is the only one of the kind in England, and it has been installed for the purposes of an extended trial test. It is used by a number of firms in America, and arrangements are being made to make the apparatus in England by the Equipment and Engineering Company, Ltd., London.

Ewden Valley Waterworks.

Important technical details of work at the Ewden Valley Waterworks of the Sheffield Corporation are available as a result of an application by the Corporation for the loan of a further £150,000 in connection with the construction of the works. It is estimated that the total ultimate cost of the scheme will be £2,181,909, of which 16·2 per cent. is represented by remedial work. Mr. J. K. Swales, general manager and engineer of the Corporation waterworks department, considers that in thirty years' experience of reservoir work he has known of no reservoir in this country where such serious adverse conditions have been manifest as in the case of the Ewden reservoir. First, in 1924, a big slip occurred, and 400,000 cubic yards of slip material were used for the purpose of lightening that portion of the slip which it was thought would be a threat to certain permanent work. Between 1928 and 1930 there was no noticeable movement, and it was thought that the work was permanently stabilised. During the first impounding of water in the Broomhead reservoir, however, certain runs of water were found to increase in flow as the level of water rose, indicating that water was escaping from both reservoirs. Innumerable boreholes were made, and the remedial work was approved by consulting engineers. Cement injected totalled 7438 tons, and in one hole alone 1758 tons were injected. The flow of water from one relief hole was at the rate of 452,000 gallons daily. It is not proposed to do any more remedial work at More Hall reservoir, where the work of dealing with small leakages has been placed in capable hands. Further work is contemplated at the Broomhead reservoir.

Doncaster Developments.

Negotiations are almost completed for the purchase by the Doncaster Corporation of an important piece of land marked out for industrial development. This consists of 360 acres on the eastern boundary of the borough on the Doncaster side of the Wheatley Park estate. The land extends from the site of the recently erected British Bemberg artificial silk factory to the Sandall sewage works belonging to the Corporation. It is understood that negotiations are proceeding for the erection of another factory on the estate.

Gas Grid Scheme.

The Sheffield Gas Company has decided to acquire, for £48,000, the undertaking of the Elsecar, Wentworth and Hoyland Gas Company. This is an important development in connection with the South Yorkshire Gas Grid scheme.

NORTH OF ENGLAND.

(From our own Correspondent.)

Tyne Improvement Scheme.

CONTRACTS worth £120,000 have been placed this week by the Tyne Improvement Commission in connection with new cargo-handling facilities and other equipment which will improve and modernise the port. The improvements include new coal shipping staiths near the west end of the Northumberland Dock at Howden, the provision of electric 3-ton travelling cranes at Albert Edward Dock, North Shields, and a 40-ton Titan crane on the North Pier, Tynemouth. The new staiths will constitute an important addition to the loading facilities of the river. There will be two large loading berths to be used preferentially by the Hartley Main Collieries, but they will also be available for the shipment of coal from other collieries. The standage sidings to be constructed by the Hartley Main Collieries, Ltd., will connect with the London and North-Eastern Railway Company's line, and at the outset there will be accommodation for 4000 tons of coal in 20-ton wagons, together with room for 110 empty wagons. This standage may be extended to accommodate ultimately 7500 tons of coal and 160 empty wagons, as trade may demand. The wagons will discharge into hoppers, and thence the coal will be delivered on to electrically driven conveyor belts. The length of the berth will be 750ft., thus giving accommodation for two large ships to be loaded at one time. The staith and its equipment have been designed by Mr. R. F. Hindmarsh, chief engineer to the Commission, who has had wide experience in coal-handling installations, in consultation with Mr. C. A. Nelson, managing director of the Hartley Main Collieries. The contract for the electric coal conveying and loading plant has been placed with F. Turnbull and Co., Heaton Junction; the electrical apparatus will be supplied by the British Thomson-Houston Company, Ltd.; Brims and Co., Ltd., Newcastle, will execute the work connected with the foundations and jetty, and the details for the reinforced concrete work have been supplied by L. G. Mouchel and Partners, Ltd., Newcastle.

Cleveland Iron Trade.

Business has been very quiet this week in consequence of the holidays, but the market remains steady. Home consumers have recently been inquiring fairly freely for material to be delivered over periods next year, and the outlook is regarded as encouraging, but prospects of improvement in export trade are hardly so promising. In addition to the much-discussed question of import tariffs, serious barriers to business with customers abroad are the uncertain rates of exchange. The already limited production of Cleveland pig iron has been further curtailed this week by a blast-furnace going out of operation for repairs. This reduces the number in blast to seventeen out of the eighty-eight blast-furnaces on the North-East Coast. Prices are firm, No. 1 Cleveland foundry iron being 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

Hematite Pig Iron.

East Coast hematite pig iron quotations are very irregular, with the tendency slightly upward. Producers protest that prices are altogether unremunerative. Consumers claim that they can purchase ordinary qualities at as low as 65s., but makers report sales up to 66s.

Iron-making Materials.

In the foreign ore trade new business is rarely heard of, but there have been substantial deliveries under running contracts. Best Rubio ore is nominal at 16s. 6d. c.i.f. Tees. Demand for blast-furnace coke is also quiet, good medium qualities being quoted at 16s. 6d., delivered at the works.

Manufactured Iron and Steel.

The manufactured iron and steel trade is dull, and prices generally unchanged, but a better demand for galvanised sheets has developed, and £9 5s. is a minimum figure.

Contracts for Armstrongs.

Armstrong, Whitworth and Co., Ltd., are to effect conversions on seven vessels. Five of the vessels belong to the Ellerman Line and the other two are owned by the Anglo-American Oil Company. Four of the Ellerman vessels are to be fitted with a new superheate. system, and the other will have the Bauer-Wach system. The two tankers will have a superheater system installed. The contracts will mean the employment of a large number of men at Low Walker and also at the Scotswood engine works of the firm.

The Coal Trade.

The outlook for the Northern coal trade is considerably brighter. There has been a spurt to get tonnage stemmed before the end of the year, and loading turns are practically full for the best type of fuel, while a satisfactory amount of trade is booked for the lower grades. This is a seasonal move to some extent, but it coincides with an improvement in the foreign trade, which was not anticipated a few weeks ago. More business is coming forward from America, the West Indies, Italy, and also the Scandinavian countries. The low value of the £ abroad is a bargaining factor that is beating foreign competition and enabling exporters in the North of England to gain a footing in markets that are entirely new, and also to regain some of their lost trade. With an improved foreign trade and a fairly active home business, prospects are somewhat more promising for the beginning of 1932. The shipment of Durham coke to the United States continues on a good scale. The latest cargo amounts to 4200 tons. It is fully expected that four or five more cargoes will be dispatched within the next few weeks. This constitutes an entirely new trade for the North-East. Before the suspension of the gold standard and the consequent fall in the £, the Northern States in America always bought American coke, but now consumers find it advantageous to take a good proportion of the Durham fuel. Northumberland steams are scarce for two or three weeks ahead, but offers at 13s. 9d. and up to 14s. are occasionally indicated for odd parcels. Durham best steams are moving freely under old contracts, but new business is not pressing on the market, and 15s. is quoted for any date of shipment. Small steams are a slow trade at 8s. 6d. Durham gas coals, while in good demand, are not scarce and offer at 14s. 6d. to 14s. 9d. Secondary gas remain abundant at 13s. 6d., but there are numerous inquiries circulating. The bunker position is firm, and the recent heavy bookings and substantial forward inquiry encourage producers. Mediterranean coaling stations are taking much larger quantities. Gas coke is a strong market, and makers rapidly clear all output, stocks being now at a low ebb. Best qualities are firm at 19s. Patent oven coke shows a substantial demand. Shipments are steadily increasing, and prices tend firmer at 16s. 6d. to 17s. 6d., and for superior makes at 18s. to 21s.

SCOTLAND.

(From our own Correspondent.)

Markets Unchanged.

THE Scotttish steel, iron and coal markets hold nothing of fresh interest, conditions being quiet generally. The cessation of work on the new Cunarder has, to a large extent, dispelled the more optimistic tone which has been apparent during the past few weeks. On the whole, inquiries are more regular than they were some months ago, but there has been very little definite movement towards a necessary increase in business, apart from one or two instances, notably black sheets. As a result of the prevailing depression, the holiday season, now almost due, will be unusually prolonged.

Steel.

The demand for steel for export is moderate and fairly regular in certain lines, but there is much need for an improvement in heavy material. The position in the sheet industry shows distinct expansion and mills employed on black sheets have fairly regular employment. The lighter sheets are principally in demand. Galvanised descriptions are not so well specified, producers finding some difficulty in securing business in the face of keen competition from English material. Actual business in tubes is still restricted, but the inquiry is more encouraging.

Iron.

The Scottish iron market is still devoid of any encouraging feature. Bar iron and re-rolled steel bars continue to meet a very poor demand, and makers are decidedly short of orders. Bar iron prices are unchanged, while re-rolled steel bars are quoted about £6 7s. 6d. home and £6 5s. per ton export.

Pig Iron.

The number of furnaces in blast in Scotland remains at five, and supplies are still ample to meet all requirements. Prices remain on recent levels.

Scrap.

The firmness of scrap is fully maintained, cast iron machinery being still quoted 57s. 6d. to 60s., and heavy steel 40s. to 42s. 6d. per ton.

Coal.

The Scottish coal market is a shade stronger because of some pressure for supplies to complete shipments before the end of the year. The curtailment of output and the closing down of pits under the quota system have caused a scarcity of those descriptions which are in demand. Fifeshire steams are not too plentiful, but shipments have been hindered by a shortage of tonnage at the ports. Lothians steams move freely, but Lanarkshire round coals are not too easily obtained. All sizes of smalls are difficult to arrange and prices are inclined to rise, even though business has not been so good since further restrictions were put upon imports into continental countries. Two collieries in Fifeshire with a joint output of 800 tons per day closed last week, and another with an output of 1700 tons per day closed early this week.

WALES AND ADJOINING COUNTIES.

(From our own Correspondents.)

The Coal Trade.

HEAVY loading pressure was experienced this week at the docks in this area. This was partly caused by the fact that exporters were desirous of getting their cargoes away before the holidays, and partly by a considerable amount of tonnage being delayed last week owing to the fog and bad weather then prevailing. Despite the fact that tonnage was not ready when it was expected, the shipments last week were quite good. According to the returns of the Great Western Railway Company the total for the six docks under its control was 487,245 tons, which was 20,310 tons better than the preceding week, and compares with 494,149 tons for the corresponding period of last year. This week the returns cannot be expected to be up to the total for last week, owing to the holidays, but they should be relatively satisfactory, because the tonnage was in dock ready to be loaded. At the end of last week the dock returns showed that there were twenty-seven vacant loading berths and only one steamer waiting; but on Monday there was quite a transformation. The situation was that only five berths were vacant, and no less than seventeen steamers were waiting for a turn, of which twelve were at Cardiff, Penarth and Barry, at which ports steam coals are mainly shipped. Prompt supplies of coal were, as a consequence, rather difficult to secure; that is, in the case of particular grades, but there was not actually much new business on the market. Most interest has centred in contract operations, and in this connection it is noteworthy that business in washed smalls for account of the Athens Electricity Works which has been secured for the past two years by Turkish coals, has again come to South Wales. The contract is for 100,000 tons, and the delivery commences from July next at Piræus. This order has been secured by the Maris Export Company. It is also reported that the Madrid, Zaragossa and Alicante Railway of Spain has placed its contract with three firms for the supply of about 50,000 tons of large steam coals for delivery at Carthagena, Alicante and Barcelona, but in regard to the most important business—that relating to the inquiry from the Egyptian State Railways for 140,000 metric tons of locomotive coals—no news up to the time of writing had come to hand. The tenders that were sent in held good up to the early part of this week.

Christmas Holidays.

The official holidays in the South Wales coalfield this Christmas have been fixed for two days, namely, Friday and Saturday. The same applies to the pitwood workers at the docks, while, in the case of the coal trimmers and tippers, arrangements were made for two short shifts to be worked on Thursday, the 24th, from 7 a.m. to noon and from noon to 5 p.m., with no work on Friday and Saturday. Normal working hours will be resumed on the following Monday.

An Important Experiment.

Elders and Fyffes, Ltd., the well-known fruit importers and shipowners, are carrying out an important experiment at Swansea and Port Talbot, which, if successful, should be of great advantage to those ports. Two of this company's steamers are now at these docks, the "Reventazon" at Swansea and the "Pacuare" at Port Talbot. The first-named ship will take about 1800 tons of coal as bunkers, and the last-named about 1500 tons. Elders and Fyffes, Ltd., are testing the facilities of Swansea and Port Talbot as against, as in the past, coaling at Continental ports. Questions of cost, &c., will, of course, enter into the consideration when deciding whether the company will send all its steamers to South Wales to bunker. If this be fixed, it will be a good thing for the district, as it will mean the establishment eventually of permanent offices, the supply of stores, and the expenditure of a considerable amount of money in the course of time, as repairs to steamers will be carried out; in fact, everything will be done for the ships at Swansea, more particularly, except the discharge of the vessels. If the decision is come to, and in future the bunkering of all steamers is to be carried out in South Wales, it will mean the consumption annually of about 200,000 tons of coal.

Tour of Iron and Steel Works.

This week Mr. Leslie Hore-Belisha, the Parliamentary Secretary to the Board of Trade, has been on a visit to South Wales for the purpose of inspecting the leading iron and steel works. His report will be available for the information of the Government in considering the question of the imposition of a tariff. During last week-end Mr. Hore-Belisha was the guest of Mr. and Mrs. Whitehead at Abergavenny, and on Monday visited the Cwrtybella Works, Newport, belonging to Messrs. Whitehead, where he saw the mills operating on the basis of Nos. 1 and 2 full time, No. 3 single shift. The same day he also toured the Dowlais Works at Cardiff belonging to the British (Guest, Keen and Baldwins) Iron and Steel Company, Ltd., and expressed himself as very much impressed with up-to-dateness of all the works he had that day seen. On Tuesday he proceeded to Port Talbot to inspect the Mansel Tin-plate Works of Byass and Co., and the Margam Iron and Steel Works, while on Wednesday he was down to go to the Elba Steel Works, Gowerton, and the steel, tin-plate and sheet works of the Grovesend undertaking, to be followed by a visit to the works of the Llanelly Steel Company, Ltd., at Llanelly, after which he was to attend a dinner of representatives of the steel and tin-plate makers at Swansea. His tour also included a visit to the King's Dock Tin-plate Works of Baldwins, Ltd., on Thursday, to be followed by a luncheon at the Mansion House given by the Mayor of Swansea.

Current Business.

Operations in coals for early loading practically came to an end last week, since which the efforts of exporters and collieries has been to load and sail steamers before the holidays. Many vessels have come along which should have put in a much earlier appearance, so that this has helped to cause a certain amount of congestion at the docks. The tone of the market remains unchanged, and prices have not altered in any respect. It is generally realised that the loading pressure now being experienced is only likely to be temporary, as business is not coming along in sufficient volume to absorb the outputs of collieries. Coke continues to be very steady, but patent fuel displays no development, while pitwood keeps about 24s. 6d. to 25s.

CATALOGUES.

HOLMAN BROS., Ltd., Camborne.—List No. 205/31 on the "James" screens.

HILL AND SMITH, Ltd., Brierley Hill, Staffs.—"Iron in Art and Construction."

HIGH SPEED STEEL ALLOYS, Ltd., Ditton-road, Widnes, Lancs.—"Vanadium in Steel."

HEAD, WRIGHTSON AND CO., Ltd., Thornaby-on-Tees.—A brochure on "Hed Writ" steels.

MARSHALL, SONS AND CO., Ltd., Gainsborough.—Catalogue of the tilting drum type concrete mixer.

T. TINGLEY, Ltd., 92, Brandon-street, S.E. 17.—Illustrated price list of rubber-tired wheels and castors.

ENGLISH ELECTRIC COMPANY, Ltd., Stafford.—Leaflets on flameproof switch pillars and mercury rectifiers.

MOSS GEAR COMPANY, Ltd., Tyburn, Birmingham.—Booklet No. 26, describing the firm's works and products.

BRITISH STEELWORK ASSOCIATION, Artillery House, London, S.W. 1.—"Steel and the Attendant Industries."

PRIESTMAN BROS., Ltd., Hull.—A catalogue of ½ and ¾ cubic yard, full-circle swing, oil-engine-driven excavators.

SHEFFIELD STEEL PRODUCTS, Ltd., Templeborough Works, Sheffield.—Price list of "S S P" files for use in filing machines.

BROOKHURST SWITCHGEAR, Ltd., Northgate Works, Chester.—Detailed illustrated price list of A.C. and D.C. control gear.

INDEPENDENT PNEUMATIC TOOL COMPANY, 40, Broadway, London, S.W. 1.—Catalogue No. 19 of "Thor" pneumatic tools.

ALFRED HERBERT, Ltd., Coventry.—"The Ever Open Door," a booklet describing the works and present activities of the firm.

STURTEVANT ENGINEERING COMPANY, Ltd., 147, Queen Victoria-street, E.C. 4.—Publication No. 1056 on steel plate fans.

CONSETT IRON COMPANY, Ltd., Consett, Co. Durham.—Particulars of copper bearing steel made for resistance against corrosion.

CHURCHILL MACHINE TOOL COMPANY, Ltd., Broadheath, Manchester.—Folder giving details of model "B" plain grinding machines.

DEWRANCE AND CO., Ltd., 165, Great Dover-street, S.E. 1.—A 300-page bound catalogue of the firm's valves and boiler mountings.

BALDWINS, Ltd., Baldwin House, Great Trinity-lane, London, E.C. 4.—An illustrated brochure dealing with the modern developments of steel, and giving some particulars of many of the recent applications of steel in industry.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE USKSIDE ENGINEERING COMPANY, Ltd., of Newport, Mon., asks us to announce that it has secured the sole manufacturing rights of the Thomas-Vernon patented coal cutter guard.

MR. J. M. ORMSTON has been appointed a special director of Vickers-Armstrongs, Ltd. He will be in charge of the shipbuilding department at Barrow, directly responsible to Mr. J. Callander.

MESSRS. MACKNESS AND SHIPLEY, consulting electrical and mechanical engineers, are removing at the end of this month from 28, Victoria-street, Westminster, to new offices at Parliament Mansions (Orchard-street), Victoria-street, Westminster. The telephone number will remain as hitherto, Victoria 9355.

THE B.A. HOLLAND ENGINEERING COMPANY, Ltd., of 18, Victoria-street, London, S.W. 1, asks us to announce that the business, including the goodwill of Bernard Holland and Co. in air compressors, vacuum pumps, diesel engines and locomotives of all types, has been purchased and henceforth will be carried on by it under the style and title of the B.A. Holland Engineering Company, Ltd.

CONTRACTS.

C. A. PARSONS AND CO., Ltd., of Newcastle-on-Tyne, have recently received an order for three transformers, each of 6000 kVA capacity, with a voltage ratio of 13,500/3000, and for twenty-six auxiliary transformers of lower voltage ratio, to be used in connection with the new Dunston power station.

THE GENERAL ELECTRIC COMPANY, Ltd., of Magnet House, Kingsway, London, W.C. 2, has received an order from the London, Midland and Scottish Railway for the electrical equipment—on the Oerlikon system—of the new rolling stock required for the augmentation of the services on its London electrified lines, viz., Euston-Watford and Broad-street-Richmond. The order includes the whole of the traction motors, control equipment, and heating and lighting equipment for thirty-one coaches, together with a further quantity of traction motors and additional spares.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	16/- to 20/6
(1) Spanish	17/- to 19/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	16/6 to 17/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 8 6	—
No. 1 Foundry	3 12 0	—
No. 3 Foundry	3 9 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 5 6 to 3 6 0	
	3 5 6 to 3 6 0	
No. 1	3 6 0 to 3 6 6	
	3 6 0 to 3 6 6	
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
MIDLANDS—		
(c) Staffs.—	(*Delivered to Station*).	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (a) / 4 0 6 (b) / 4 5 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 10 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	10 10 0	—
Best Bars	11 0 0	—
Double Best Bars	11 10 0	—
Treble Best Bars	12 0 0	—
LANCS.—		
Crown Bars	9 15 0	—
Second Quality Bars	8 5 0	—
Hoops	12 0 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 5 0 to 10 7 6	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 7 6	—
Gas Tube Strip	10 10 0 to 10 12 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	9 0 0	8 10 0
„ „ (Land)	—	—
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 10 0	7 10 0
Sheets (Gal. Cor. 24 B.G.)	10 12 6	9 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	8 15 0	—
SHEFFIELD—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	6 0 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
MIDLANDS—		
Small Rolled Bars (all British)	7 15 0 to 8 0 0	—
Small Re-rolled Bars	6 17 6 to 7 0 0	—
Billets and Sheet Bars	5 7 6 to 5 10 0	—
Galv. Sheets, f.o.b. L'pool	9 5 0	—
(2) Staffordshire Hoops	9 10 0	—
(d) Angles	8 7 6	—
(d) Joists	8 15 0	—
(d) Tees	9 7 6	—
(d) Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 12 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14 f.o.b.	14/- to 14/6
Block Tin (cash)	141 17 6
„ (three months)	144 17 6
Copper (cash)	40 8 9
„ (three months)	41 2 6
Spanish Lead (cash)	15 7 6
„ „ (three months)	15 15 0
Spelter (cash)	14 13 9
„ (three months)	15 2 6
MANCHESTER—	
Copper, Best Selected Ingots	44 0 0
„ Electrolytic	49 10 0
„ Strong Sheets	77 0 0
„ Tubes (Basis Price), lb.	0 0 11
Brass Tubes (Basis Price), lb.	0 0 10
„ Condenser, lb.	0 1 0½
Lead, English	16 17 6
„ Foreign	15 17 6
Spelter	15 5 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

Tungsten Metal Powder	2/4 per lb.
Ferro Tungsten	2/- per lb.

	Per Ton.	Per Unit.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£25 0 0	7/-
„ „ 6 p.c. to 8 p.c.	£24 0 0	7/-
„ „ 8 p.c. to 10 p.c.	£22 10 0	6/6
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£36 0 0	10/-
„ „ „ 1 p.c. carbon	£40 0 0	12/-
„ „ „ 0·70 p.c. carbon	£51 0 0	13/-
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	3/1 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
„ „ „	£11 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£9 10 0 scale 5/- per unit	
„ „ 75 p.c.	£16 0 0 scale 7/- per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£250 to £255	
Ferro Cobalt	8/6 per lb.	

FUELS.

	Export.
SCOTLAND.	
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	13/9
„ „ Ell	14/6
„ „ Splint	14/3 to 15/3
„ „ Trebles	16/-
„ „ Doubles	13/6
„ „ Singles	10/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/6
„ „ Jewel	17/-
„ „ Trebles	16/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 13/6
Screened Navigation	17/-
Trebles	16/- to 17/-
Doubles	13/6 to 14/6
Singles	10/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	12/6 to 12/9
Secondary Steam	12/3
Trebles	16/- to 16/6
Doubles	13/6
Singles	10/6

	Inland.	Export.
(8) N.W. COAST— ENGLAND.		
Steams		21/-
Household		32/6 to 51/6
Coke		20/- to 21/-
NORTHUMBERLAND—		
Best Steams		13/9 to 14/-
Second Steams		12/- to 12/6
Steam Smalls		8/6 to 9/-
Unscreened		12/6 to 13/-
Household		27/- to 39/-
DURHAM—		
Best Gas		14/6 to 14/9
Second		13/6
Household		25/- to 37/-
Foundry Coke		24/-
SHEFFIELD—	Inland.	
Best Hand-picked Branch	26/- to 27/-	—
South Yorkshire Best	24/- to 25/-	—
Derbyshire Best Bright House	20/6 to 21/6	—
Best House Coal	22/- to 23/-	—
Screened House Coal	19/- to 20/6	—
Best Screened Nuts	17/- to 18/-	—
Small Screened Nuts	15/6 to 16/6	—
Yorkshire Hards	17/- to 18/6	—
Derbyshire Hards	17/- to 18/6	—
Rough Slacks	9/- to 10/-	—
Nutty Slacks	8/- to 9/-	—
Smalls	5/6 to 6/6	—
Blast-furnace Coke (Inland)	11/- to 12/- on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b., 17/- to 18/-		

CARDIFF— (9) SOUTH WALES.	
Steam Coals:	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/- to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/-
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/- to 13/6
Ordinary Smalls	11/- to 13/-
Washed Nuts	19/- to 27/6
No. 3 Rhondda Large	19/9 to 20/-
„ „ Smalls	15/- to 16/-
No. 2 „ Large	17/- to 17/3
„ „ Through	15/6 to 16/-
„ „ Smalls	14/- to 14/3
Foundry Coke (Export)	22/- to 36/6
Furnace Coke (Export)	16/- to 17/6
Patent Fuel	19/- to 19/6
Pitwood (ex ship)	24/3 to 25/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	36/- to 38/6
Seconds	27/- to 31/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 48/6
Nuts	40/- to 48/6
Beans	28/6 to 32/6
Peas	21/- to 22/-
Breaker Duff	8/6 to 9/6
Rubbly Culm	8/3 to 8/9
Steam Coals:	
Large	20/- to 20/6
Seconds	18/- to 20/-
Smalls	11/6 to 13/-
Cargo Through	16/- to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. (d) Rebate: Joists (minimum), 22/6: Ordinary Ship, Bridge, and Tank Plates and Sections. 15/- if home consumers confine purchases from associated British Steel Makers. Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

Import Restrictions.

THERE can be no hope of improvement in the iron, steel, and engineering industries until something is known of what will be done in the early future to encourage international exchanges, and as all countries now see that they must trade with each other, they are considering the ways and means by which this can best be accomplished in their particular interests. Several commercial treaties are being denounced. Following upon the super-tax of 10 per cent. against Canada, that Dominion has abrogated its treaty with France. Italy has done the same thing on the ground that the restriction of imports from that country into France is contrary to the spirit of the existing commercial treaty arrangement. Switzerland has denounced its treaty with Germany because it cannot keep out the flood of German imports. The way is being cleared for new negotiations, which tend to take the form of granting import quotas to different countries in return for equivalent quotas for other goods, so that the exchanges are expected to be beneficial to the contracting countries without prejudicially affecting the interests of home producers. This practice appears to keep competition within normal limits, and if the system becomes general it will necessarily mean a restriction of output in exporting countries, because manufacturers will not be able to dispose of any surplus beyond the quantities specified for each market. This is the basis of the negotiations now proceeding between France and Belgium, and groups of manufacturers in both countries have been asked to provide data concerning exchanges that will guide the respective Governments in preparing a commercial treaty. The same thing is being done with Germany where the different classes of goods are being examined with a view to exchange. The system is complicated, and involves so many conflicting interests that it has yet to be seen whether treaties of commerce can be established on this basis to the satisfaction of everyone. With Italy the difficulties appear to be insurmountable on account of the similarity of products. Belgium wants to import coal and iron into the north of France, where there is already an abundance of those commodities.

The Merchant Marine.

There has been a good deal of discussion in Parliament concerning the reorganisation of the Compagnie Générale Transatlantique under the direct control of the State, and in this connection an announcement has been made to the effect that work upon the construction of the new liner will only be suspended if progress on the Cunarder is not resumed. Questions of prestige outweigh considerations of economy. One argument is that if this country is alone in possessing a ship which, in point of luxury and speed, will be superior to anything else afloat, it will have a chance of monopolising much of the traffic between New York and Europe. On the other hand, the shipping companies find the situation so desperate that they would willingly consider proposals for a rationalisation of traffic, whereby the tonnage of ships could be limited and each country would be assured of its fair share of the carrying trade. Rumours that a conference may be held in Paris with a view to reaching some satisfactory arrangement appear to be based upon preliminary suggestions that may possibly be carried into effect, though previous negotiations of a similar character failed to conciliate the claims of different countries.

Cross-Channel Services.

The Chamber of Commerce of Dieppe has issued a statement protesting against the postponement of the programme of harbour improvement works and the threatened suspension of the Newhaven–Dieppe service by the State Railways, on the ground that those works are necessary in order to enable them to carry out urgent economies. It has not been possible to obtain official confirmation of the suspension of the cross-Channel service, though the fact that the boats between Southampton and Havre will only run three days a week each way from January 1st next suggests that a restriction of the service betwen Newhaven and Dieppe is not unlikely. The only official information vouchsafed is that "there is no more traffic in passengers or goods." The programme of harbour works at Dieppe was prepared specially to improve the conditions for manœuvring and berthing cross-Channel boats in the harbour, which are now very bad, but the Dieppe Shipowners' Association refuses to accept the programme without certain changes, so that it has been withdrawn for further consideration. According to the Chamber of Commerce, this decision has been seized upon by the State Railways as a pretext to consider the suppression of the service.

Unemployment.

Although there are no reliable figures of unemployment, it is admitted that the rate of increase, despite the outflow of foreign labour, is greater than in other countries, where unemployment appears to have already reached high water mark. The official figures only apply to those in receipt of "public assistance." The continual slowing down of work is affecting the whole mass of operatives who, when in work, are usually on very short time, and as there are no signs of possible improvement, the situation has become serious. The Government has rejected the Socialist scheme of the dole, on the ground that experience in Great Britain and Germany has shown it to be a disastrous expedient, and the problem of relief is to be met by further State contributions to the "public assistance" funds, and more especially by the putting in hand of the programme of public works. It is hardly likely that these works will provide adequate relief from the growing unemployment, and this serious problem, more than anything else, has influenced the Government in pushing forward as rapidly as possible its negotiations with different countries for an interchange of goods under reciprocal conditions. The protectionist policy of Great Britain is hurrying matters to a solution that, without it, would still be hanging on the dubious hopes of a European Union.

British Patent Specifications.

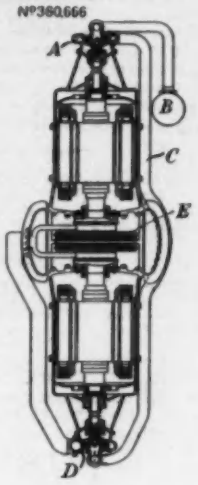
When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TURBINE MACHINERY.



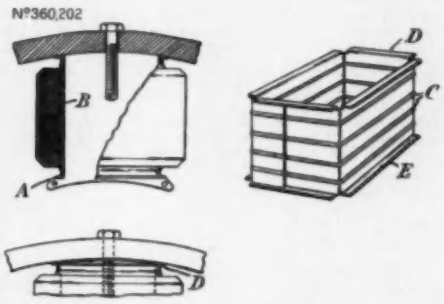
360,666. November 5th, 1930. —HIGH-PRESSURE STEAM TURBINES, Aktiebolaget Ljungstroms Angturbin, Vastra Tradgardsgatan 17, Stockholm, Sweden.

It is suggested that this machine is adaptable to the use of extra high-pressure steam without being unduly expensive or bulky. The steam is expanded in three separate turbines in series, which are all of the radial flow type. The first turbine A is of the single rotor type, and is supplied with steam from the stop valve B. Its exhaust C is taken to the second turbine D, which revolves in the opposite direction. At the centre of the machine there are two turbine discs E, of the Ljungstrom type, which finally expand the steam to condenser pressure. The electrical side of the equipment needs no description.—*November 12th*, 1931.

DYNAMOS AND MOTORS.

360,202. November 13th, 1930.—SPOOL BODIES FOR ELECTRICAL APPARATUS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

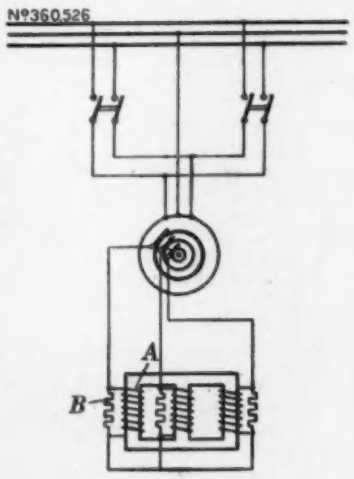
The object of this invention is to provide a simple spool body construction such that the coil and the spool will be securely retained in place on the core structure so as to prevent chafing and wear without the use of the usual coil clamps or springs. The tips of the poles are formed with shoulders A. The coils are formed on the spool body B, which is retained in place between the shoulders A and the frame of the machine, so that the coil can readily be replaced by removing the pole from the frame. In order to retain the coil in the proper position,



the spool body is provided with corrugations C. A layer of insulation is first placed on the spool body and the coil is then wound upon it. The spool body is preferably formed of sheet metal. At each end of the spool body there are flanges D and E, and the latter flange fits directly against the shoulder A of the pole piece. The flanges D are arranged so that when the spool body is on the pole piece the flanges extend directly outward from the edges of the pole at the base. The flanges D are first brought against the frame, and upon tightening the bolt the flanges D are curved slightly to conform with the frame. In this way the spool body and coil are securely retained on the pole and chafing between the spool body and the pole piece is prevented.—*November 5th*, 1931.

360,526. August 20th, 1930.—DRIVING OF ROLLING MILL MACHINES, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

The method described in this specification of driving a rolling

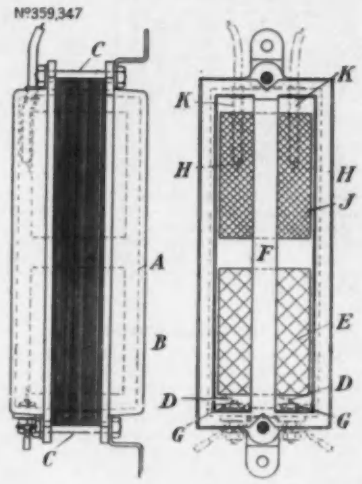


mill by means of an induction motor involves the use of an impedance starter connected to the slip rings in the manner shown. The starter consists of a combination of inductance and ohmic resistances A and B respectively, and connected in parallel. With full mains frequency as exists in the rotor at the moment of switching on the stator current, the impedance coils A have high inductance and the greater part of the current flows through the ohmic resistances B, this giving a good torque. As the motor runs up to speed and the rotor current decreases, the current in the inductive windings becomes greater in the well-known manner and in the neighbourhood of synchronism the inductive windings serve to short circuit the ohmic resistances. In consequence of the gradual reduction of the rotor resistance with increasing speed, a practically constant starting or acceleration torque is obtained. The principle will readily be understood by all who are familiar with the Boncherot double cage squirrel-cage rotor, which is not referred to in the specification.—*November 12th*, 1931.

TRANSFORMERS AND CONVERTERS.

359,347. February 19th, 1931.—ELECTRIC TRANSFORMERS, *The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C. 2.*

This invention relates to electric transformers and more particularly to electric stray field transformers of the type used for supplying luminous electric discharge tubes, and the object of the invention is to provide a compact construction of transformer which facilitates its being housed inconspicuously in the box-shaped shield for the luminous electric discharge tube. The stray field transformer consists of the back-plate A of the housing, and a housing cover between which the laminations

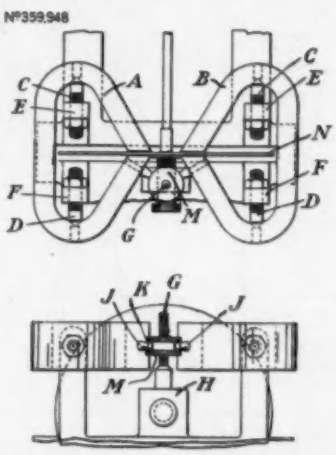


B are clamped by means of two connecting screws C. The ends D of the primary winding E, which is threaded on the central leg F of the laminations, are connected to two terminals G on a front wall of the cover. The longer ends H of the secondary winding J, similarly threaded on the central leg F, are, on the other hand, carried through the other wall of the cover into the open and serve for the direct connection of the luminous discharge tube. The ends H may conveniently be provided with an insulating sheath K. To secure the coils E, J in position on the central leg F of the laminations, the hollow space in the latter may be filled with sealing compounds.—*October 22nd*, 1931.

MEASURING AND TESTING INSTRUMENTS.

359,948. June 20th, 1930.—A.C. ELECTRICITY METERS, Frank Holden and Measurement, Ltd., both of Townsend House, Greycoat-place, London, S.W. 1.

This specification describes a mounting for a braking magnet of an A.C. electricity meter comprising a pair of axially adjustable pivots carried in parts rigid in relation to the rotor mounting, for supporting the magnet in trunnion fashion, in combination with means for rocking the magnet and maintaining it in position. For each magnet A B there is a pair of supporting screws C D carried respectively in pillars E F rigid with the meter casing. The screws C are coaxial with the screws D and the former point upwards whilst the latter point downwards,



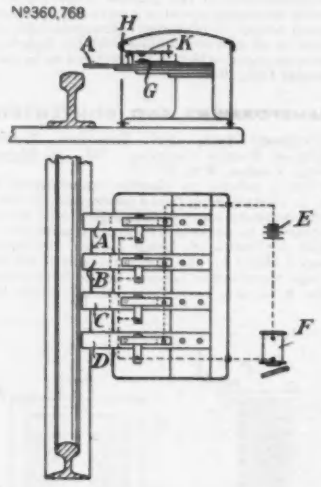
the pointed ends engaging correspondingly shaped recesses in the inner faces of the upper and lower limbs of the magnets. Locknuts are provided for the screws. A screw G provided with a milled nut is secured to a fixed pillar H and projecting pins J J attached to the magnets engage a groove K in the nut M. According to this arrangement the two magnets may be rocked simultaneously in trunnion fashion about the axes of their supporting screws by rotating the milled nut M in order to effect calibration of the meter and are retained in predetermined position. Individual vertical adjustment of the magnets in relation to the plane of the rotor N can be effected by slackening the lock-nuts of the nuts E and F and by appropriately moving the pairs of screws.—*October 20th*, 1931.

TRAMWAYS AND RAILWAYS.

360,768. February 14th, 1931.—RAIL-CONTACT APPARATUS, Leonard Mellersh-Jackson, of Haseltine, Lake and Co., 28, Southampton-buildings, Chancery-lane, London, W.C. 2.

The rail-contact device described in this specification is par-

ticularly suitable for use with train axle counting devices, and is claimed to be superior to devices which open and close contacts through a lever. In accordance with the invention, springs A, B, C, D operate the contacts in a circuit containing a battery E and a relay F, which gives the desired signal. The specification is somewhat difficult to follow, but, apparently, G are main contacts and H are auxiliary contacts, although nothing is

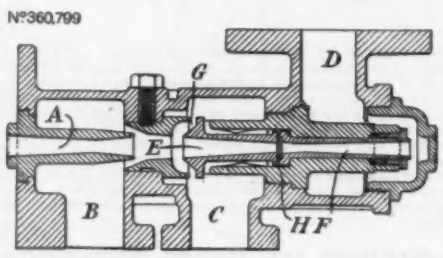


said to that effect. Upon depression by the rim of the wheel the specification states a second spring K is relieved, and in this way any unnecessary strains which are caused by variability of the wheels or by wearing down of the rails by traffic cannot react upon the contact. By using several sets of springs the unintentional operation of the contacts is made more difficult.—*November 12th*, 1931.

MISCELLANEOUS.

360,799. April 14th, 1931.—Steam Injectors, H. E. Gresham and J. N. Gresham, Ordsall-lane, Salford, Manchester.

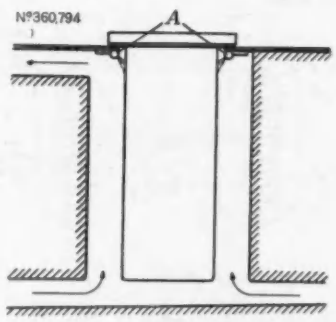
This injector is intended to overcome the trouble which is experienced with some injectors of the automatic type of the overflow not being shut off immediately the full delivery pressure is attained. The steam jet is shown at A, the water supply



at B, the overflow at C, and the delivery at D. The combining nozzle E and the delivery nozzle F are slidable in the casing. At starting up the superior pressure of the steam jet forces E and F to the right, so that there are overflow openings at G and H. When, however, delivery pressure has been established, the reaction from D drives the two nozzles to the left, and the overflow opening is closed.—*November 12th*, 1931.

360,794. March 23rd, 1931.—The Cooling of Annealed Material, Felten & Guilleaume Carlswerk Actien-Gesellschaft, of Köln-Mülheim, Germany.

The invention relates to a method of, and an apparatus for, cooling annealed material, more particularly copper which is



contained in wrought iron annealing boxes. The hot annealing boxes coming from the furnace have hitherto, according to the kind of box, either been placed on the floor of the factory or placed in special cooling pits in which the desired cooling is accelerated by artificially produced air cooling. The cooling for 1000 kilos. of annealed material takes sixteen to twenty-four hours to reach the desired final temperature. According to the new method for accelerating the cooling of the annealed material, it is proposed to sprinkle the outside of the annealing boxes containing the annealed material with water after they have left the furnace. It has been found that in this manner less than half the time previously used for cooling is required. In this way a more rapid circulation of the manufactured material and at the same time a saving in the cost of providing annealing boxes is obtained. With red-hot boxes it is advisable to use air cooling at first and water cooling later. The water sprays are shown at A.—*November 12th*, 1931.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

TUESDAY, DECEMBER 29TH.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture. The Universe of Light: Lecture I., "The Nature of Light," by Sir William Bragg, F.R.S. 3 p.m.

THURSDAY, DECEMBER 31ST.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture. The Universe of Light: Lecture II., "Light and the Eye," by Sir William Bragg, F.R.S. 3 p.m.

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FRIDAY, JANUARY 1ST.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. "Photogravure and the Intaglio Press," by Mr. B. A. Gooderham. 7.30 p.m.

SATURDAY, JANUARY 2ND.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture, "The Universe of Light"; Lecture III., "Light and Colour, I.," by Sir William Bragg, F.R.S. 3 p.m.

MONDAY, JANUARY 4TH.

Wolverhampton and District Engineering Society.—The Victoria Hotel, Wolverhampton. "The Mechanical Principles Embodied in Weighing Machines," by Mr. W. A. Benton. 7.30 p.m.

TUESDAY, JANUARY 5TH.

Institution of Automobile Engineers.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Oil Consumption in Relation to Cylinder and Piston Wear," by Mr. E. C. Ottaway. 7.45 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture, "The Universe of Light, Lecture IV., Light and Colour, II.," by Sir William Bragg, F.R.S. 3 p.m.

WEDNESDAY, JANUARY 6TH.

Institution of Automobile Engineers.—Queen's Hotel, Birmingham. "The Training of Young Automobile Engineers," by Mr. B. G. Robbins. 7.30 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. "Multi-channel Television," by Mr. C. O. Browne. 6 p.m.

THURSDAY, JANUARY 7TH.

Institution of Civil Engineers: Birmingham and District Association.—In the Chamber of Commerce, Birmingham. "The Underpinning of a Heavy River Wall," by Mr. Wm. Muirhead. 6 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture, "The Universe of Light, Lecture V., Light from the Sky," by Sir William Bragg, F.R.S. 3 p.m.

FRIDAY, JANUARY 8TH.

Illuminating Engineering Society.—At the House of the Royal Society of Arts, John-street, Adelphi, London, W.C. "Motor Car Headlights," by Mr. E. S. Calvert. Discussion 7 p.m.

Institution of Mechanical Engineers.—Storey's Gate, St. James's Park, London, S.W. 1. Thomas Lowe Gray Lecture, "Modern Types of Propelling Machinery for Mercantile Marine Use," by Mr. Sterry B. Freeman. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. "Refrigeration: Modern Practice and Practical Calculations," by Mr. B. C. Oldham. 7.30 p.m.

SATURDAY, JANUARY 9TH.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture, "The Universe of Light, Lecture VI., Light from the Sun and the Stars," by Sir William Bragg, F.R.S. 3 p.m.

MONDAY, JANUARY 11TH.

Institute of Metals: Scottish Local Section.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Some Properties of Fire-bricks," by Mr. H. C. Biggs. 7.30 p.m.

Institution of Electrical Engineers.—Victoria Embankment, W.C. 2. Informal meeting. Correction of title to discussion. "The Relative Importance of Current and Installation Costs as Affecting the Sale of Electricity," opened by Mr. H. T. Young.

TUESDAY, JANUARY 12TH.

Institute of Metals: Birmingham Local Section.—In the Chamber of Commerce, New-street, Birmingham. "Stainless Steel," by Mr. J. H. G. Monypenny. 7 p.m.

Institute of Metals: North-East Coast Local Section.—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. Discussion on "Defects in Non-ferrous Castings," by Messrs. R. Dowson, S. G. Homfray and A. Logan. 7.30 p.m.

Institution of Automobile Engineers.—Graduates' Meeting, Watergate House, Adelphi, W.C. 2. "Carburisation," by Mr. E. W. Knott. 7.25 p.m.

Institution of Electrical Engineers.—Hotel Metropole, Leeds. "Two Transmission Line Problems," by Mr. P. J. Ryle. 7 p.m.

Institution of Engineers and Shipbuilders in Scotland.—39, Elmbank-crescent, Glasgow. "Modern Methods of Steel Bridge Manufacture," by Mr. J. Thomson. 7.30 p.m.

THURSDAY, JANUARY 14TH.

Institute of Metals: London Local Section.—In the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W. 1. "X-Ray Examination of Alloys," by Mr. G. D. Preston. 7.30 p.m.

Institution of Civil Engineers: Birmingham and District Association.—In the Chamber of Commerce, Birmingham. Vernon Harcourt Lecture, "The Mechanical Handling of Coal at Ports," by Mr. N. G. Gedye, 6 p.m.

Institution of Mechanical Engineers: Yorkshire Branch. Hotel Metropole, Leeds. Annual General Meeting. "Recent Developments in the Treatment of Boiler Water," by Dr. A. W. Chapman. 7.30 p.m.

FRIDAY, JANUARY 15TH.

Institute of Metals: Sheffield Local Section.—In the Non-ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. "Stresses in Metals," by Mr. A. Wragg. 7.30 p.m.

Institution of Mechanical Engineers.—Storey's Gate, St. James's Park, S.W. 1. Informal Meeting. Discussion on "Industrial Conditions in Russia," introduced by Mr. J. Fearn. 7 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. "The Development of the Loud Speaker," by Mr. H. J. N. Riddle. 7.30 p.m.

THURSDAY, JANUARY 21ST.

Institute of Metals: Birmingham Local Section.—In the Chamber of Commerce, New-street, Birmingham. "Electric Welding of Non-ferrous Alloys," by Dr. A. Burstall. 7 p.m.

Institution of Structural Engineers.—Hotel Metropole, Leeds. "The Employment of Structural Engineers as Specialists," by Mr. W. T. Cresswell. 7 p.m.

FRIDAY, JANUARY 22ND.

Institution of Locomotive Engineers.—Hotel Metropole, Leeds. "Progressive Methods Applied to a Modern Shop for Electric Rolling Stock," by Colonel E. Graham. 7.15 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Informal meeting. Lecture, "Notes on Hydraulic Installations in New Zealand," by Mr. H. S. Lamburd. 7.30 p.m.

WEDNESDAY, JANUARY 27TH.

British Wood Preserving Association.—In the Lecture Hall, Auctioneers' and Estate Agents' Institute, 29, Lincoln's Inn-fields, London, W.C. 2. "Diseases of Timber," by Mr. K. St. G. Cartwright. 6 p.m.

Institution of Automobile Engineers.—Engineers' Club, Manchester. "Transmission," by Mr. L. H. Pomeroy. 7 p.m.

MONDAY, FEBRUARY 1ST.

Wolverhampton and District Engineering Society.—The Victoria Hotel, Wolverhampton. "Waste Heat Boilers," by Mr. F. Jones. 7.30 p.m.

SATURDAY, FEBRUARY 6TH.

Institute of British Foundrymen: Lancashire Branch.—Grand Hotel, Manchester. Annual dinner. 6.30 p.m.

MONDAY, FEBRUARY 15TH.

Wolverhampton and District Engineering Society.—The Victoria Hotel, Wolverhampton. "Beet Sugar Manufacture," by Dipl. Ing. Karl Hampel. 7.30 p.m.

MONDAY, MARCH 7TH.

Wolverhampton and District Engineering Society.—The Victoria Hotel, Wolverhampton. "Steam Generation in Factories," by Mr. H. E. Partridge. 7.30 p.m.

Air Flow Measurements.—In connection with the memorandum on air flow measurement, published on page 650 of our last issue, we are asked to point out that whilst the formula for calculating the flow is correct for air, the square root of Δ must be used for any other gas, the general formula being:—

$$Q = 0{\cdot}1148\, M\, \Omega\, \delta\, \sqrt{\Delta}\, d_2^2\, \sqrt{(m_2/T)}\ \text{lb./sec.}$$

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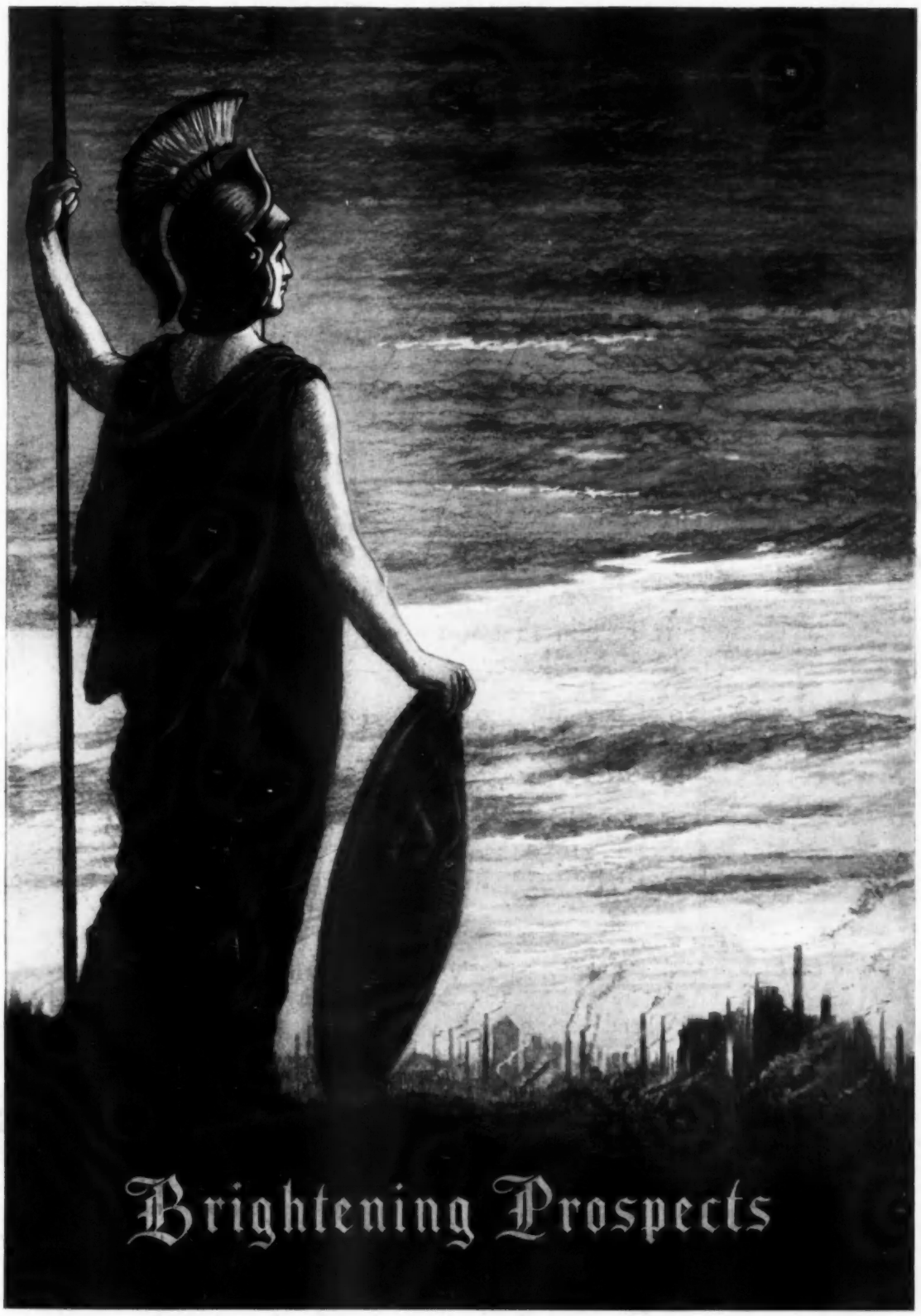

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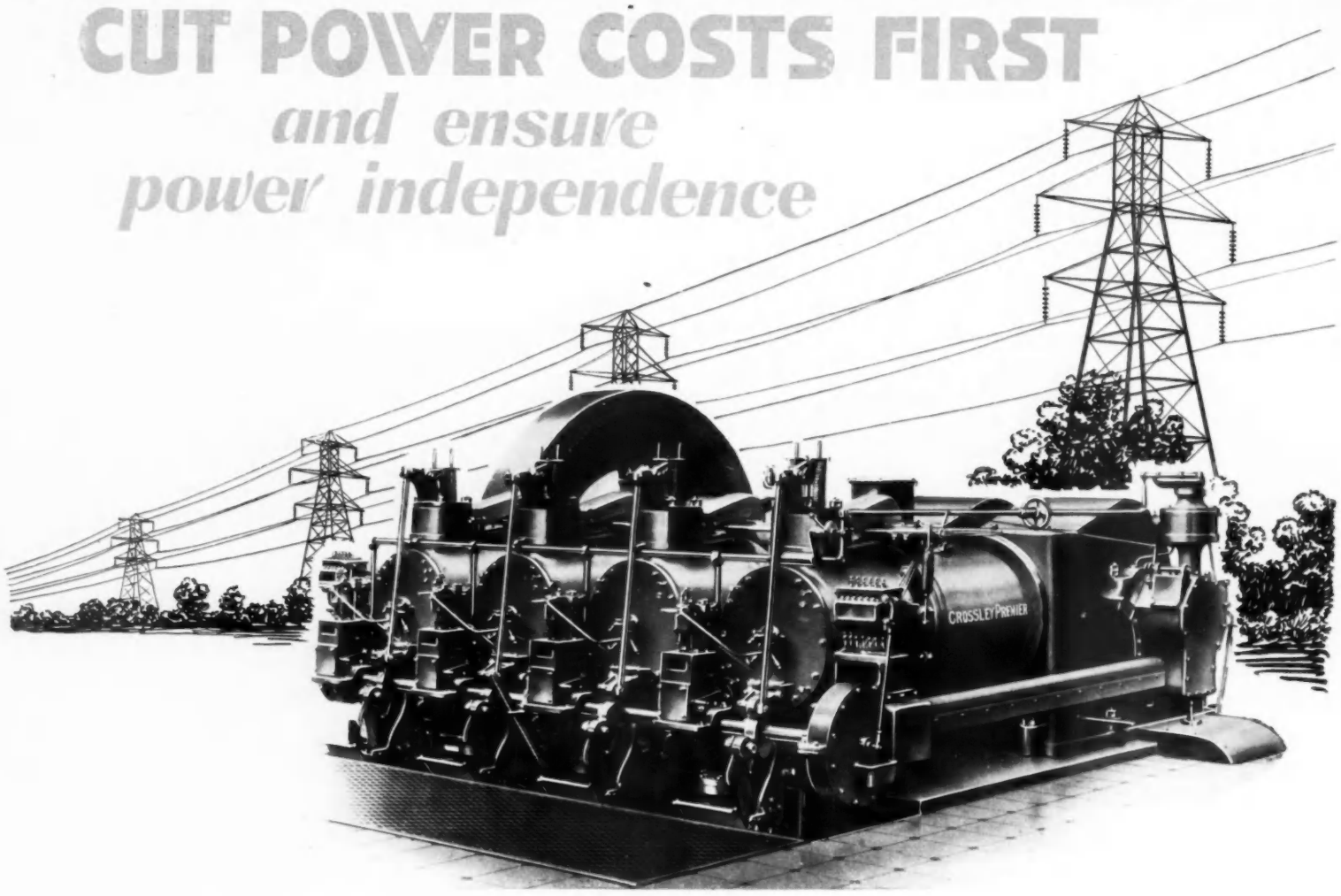

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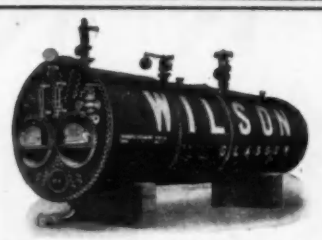

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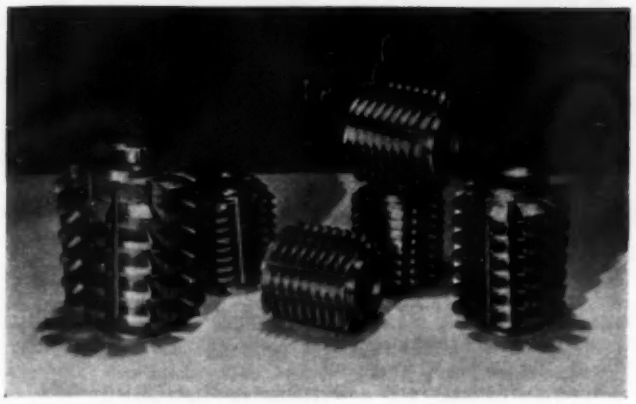

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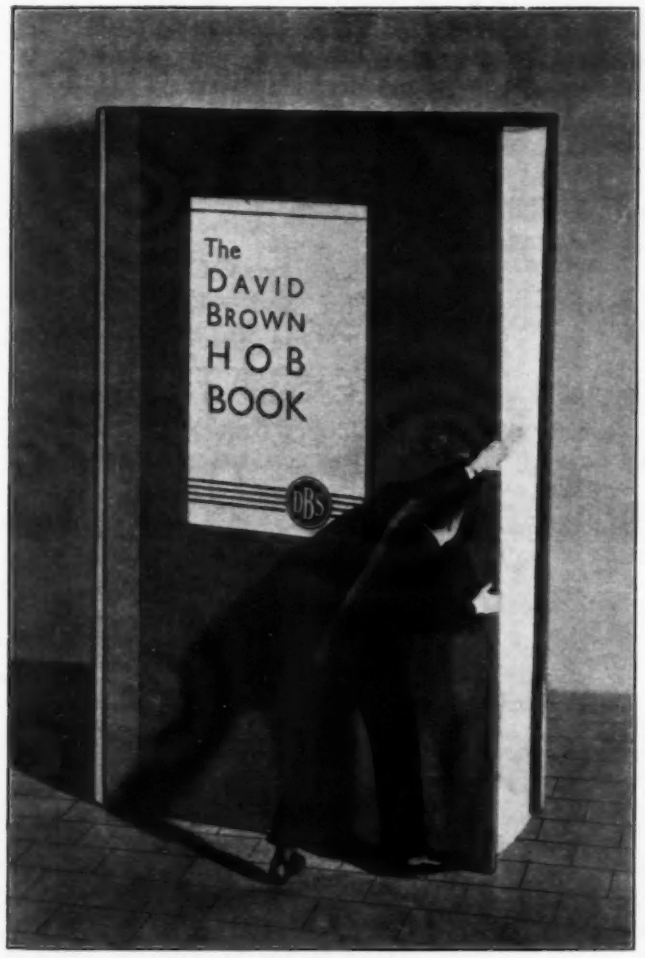

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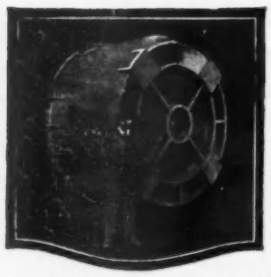

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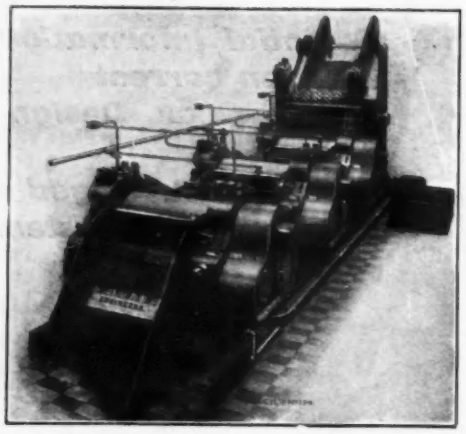

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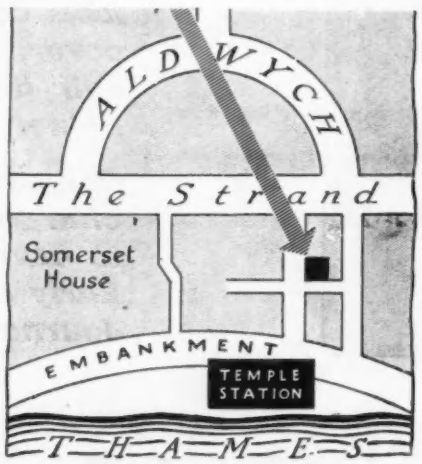

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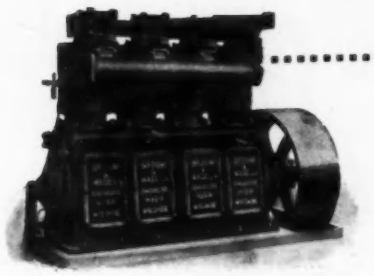

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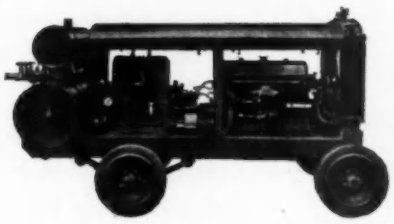

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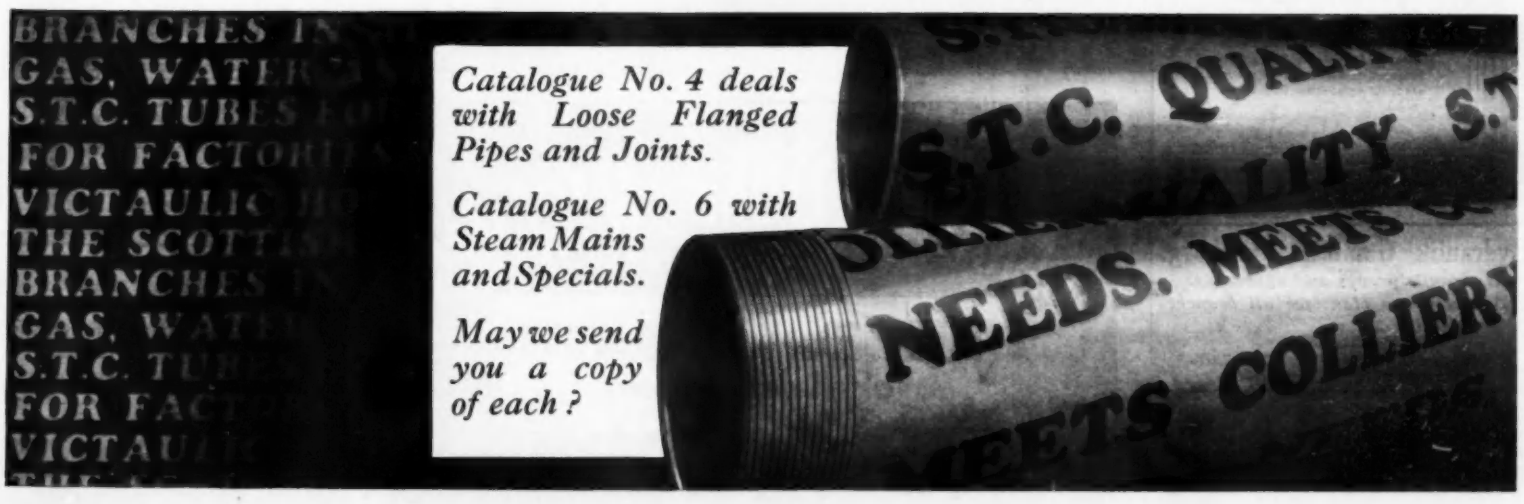

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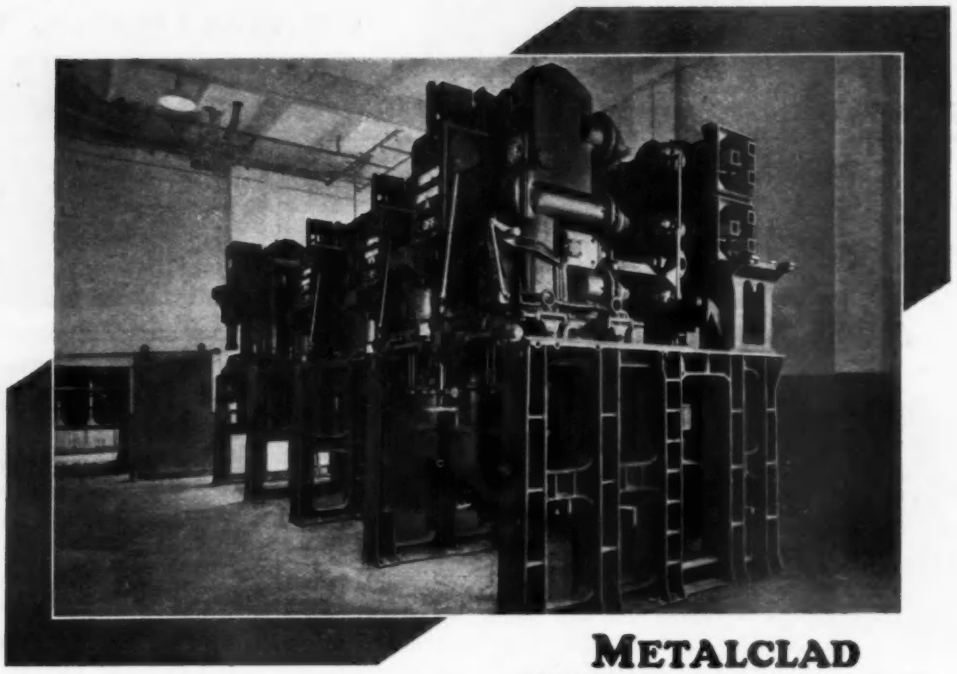

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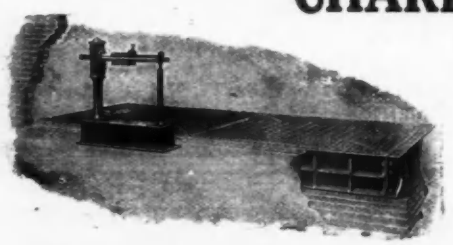

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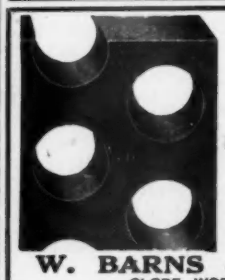

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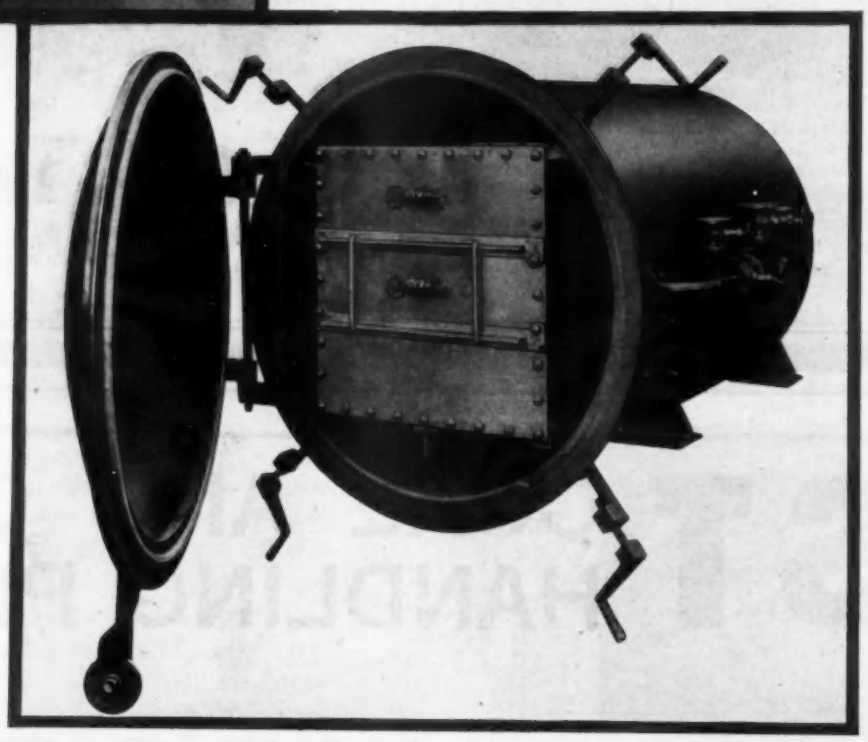

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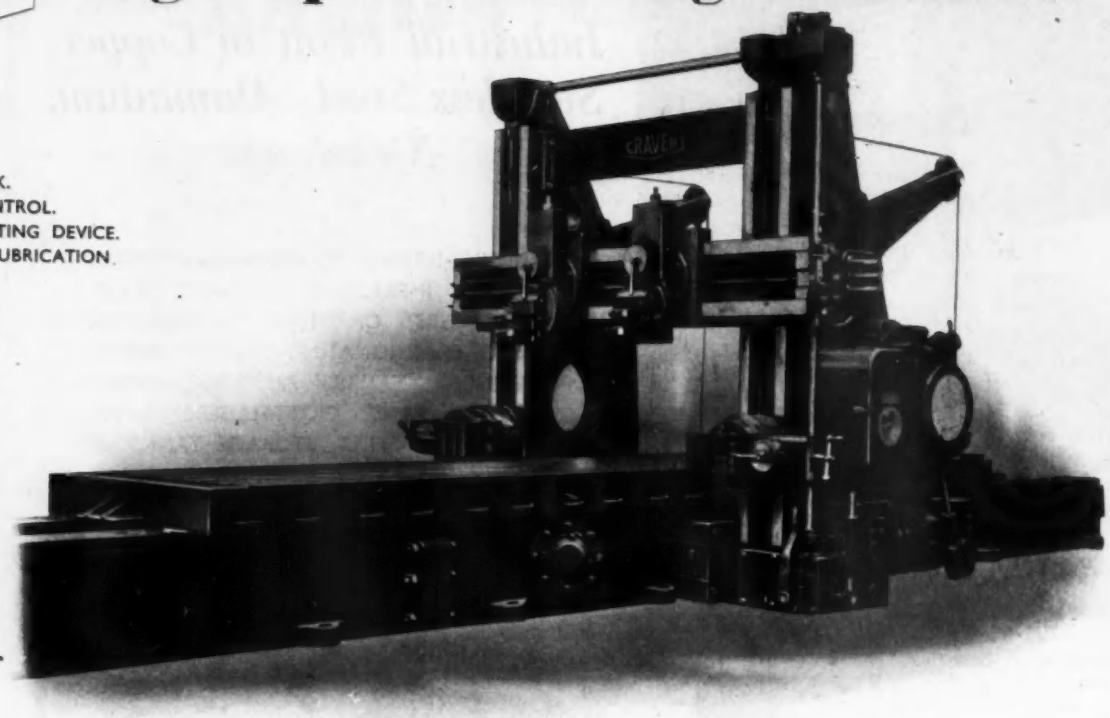

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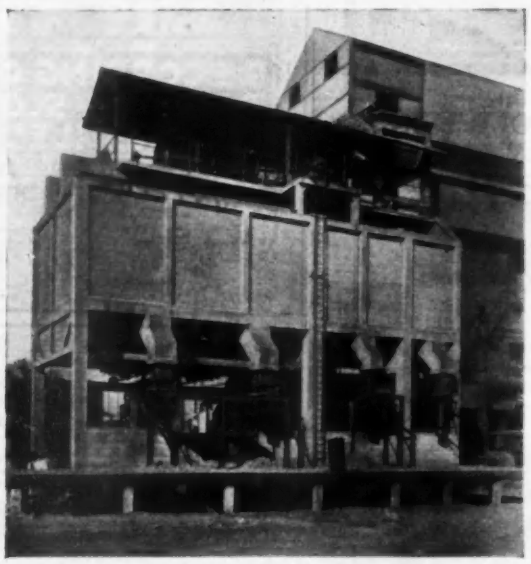

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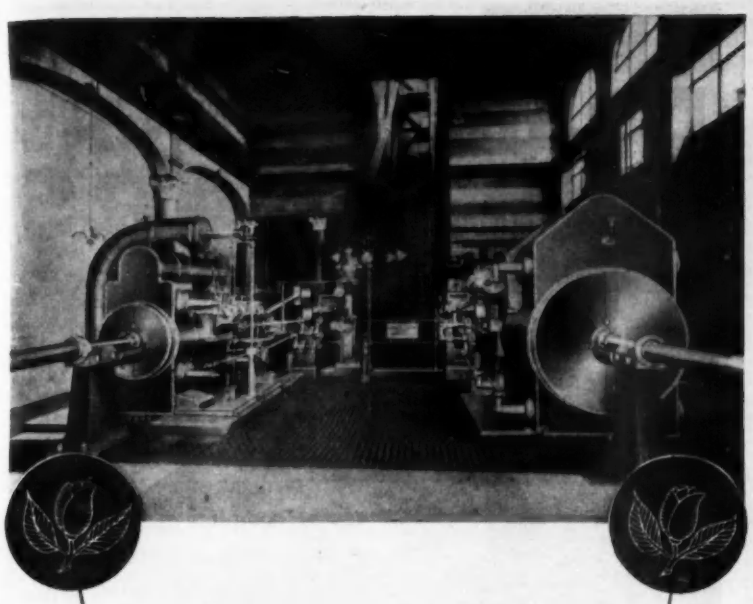

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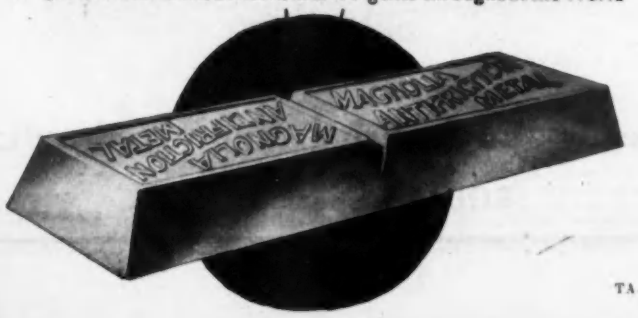

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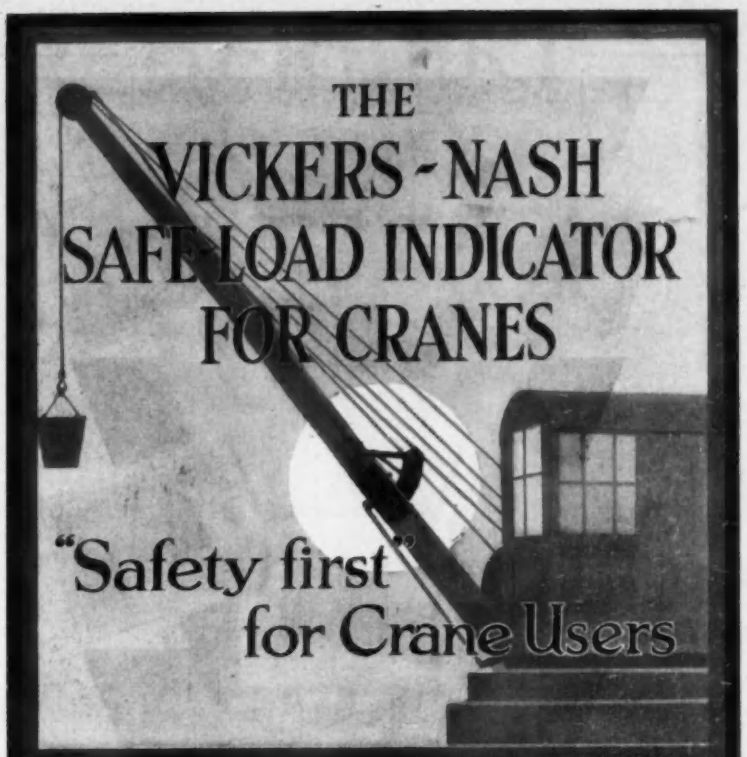

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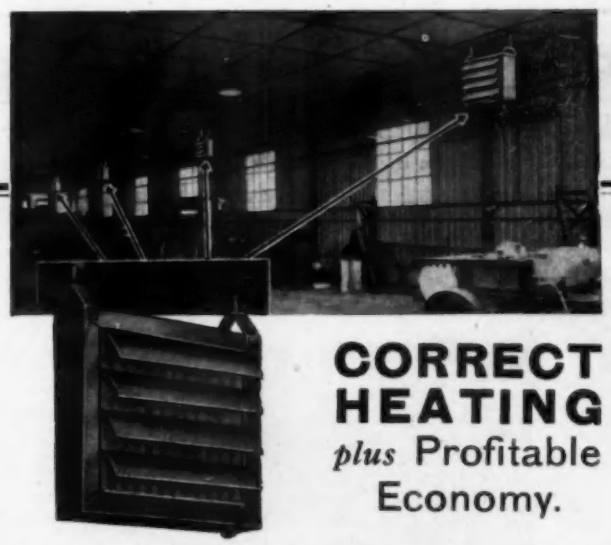

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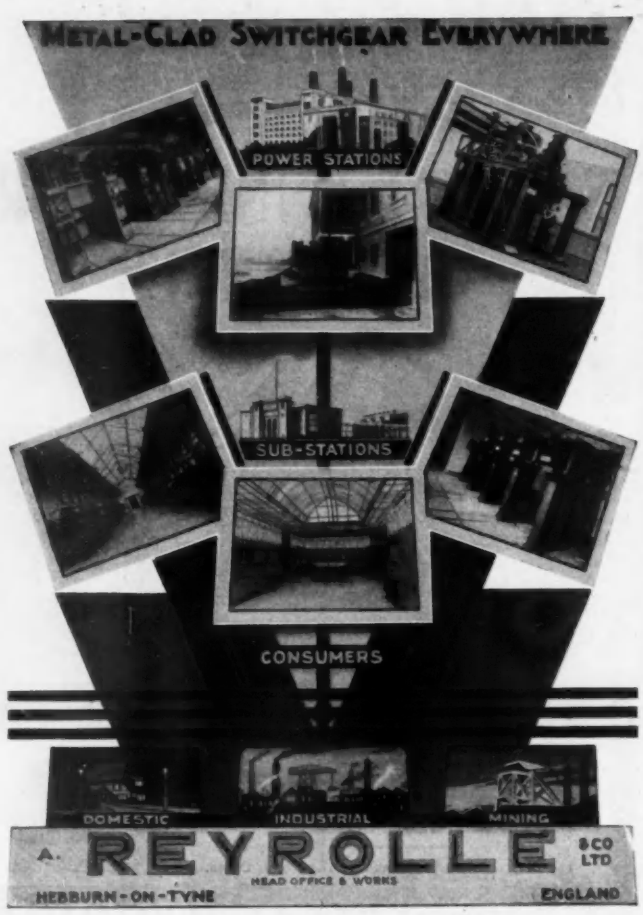

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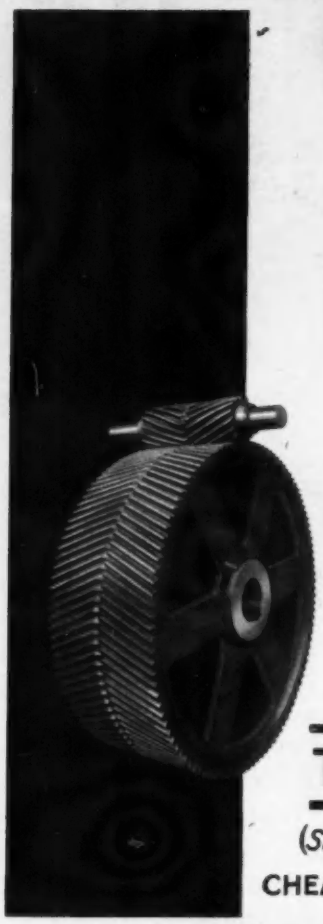

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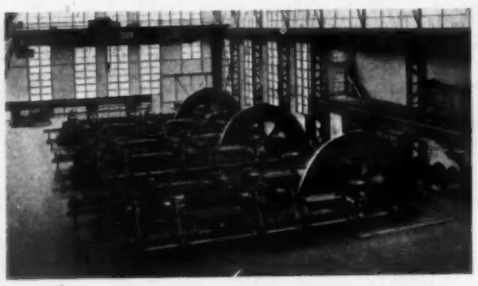

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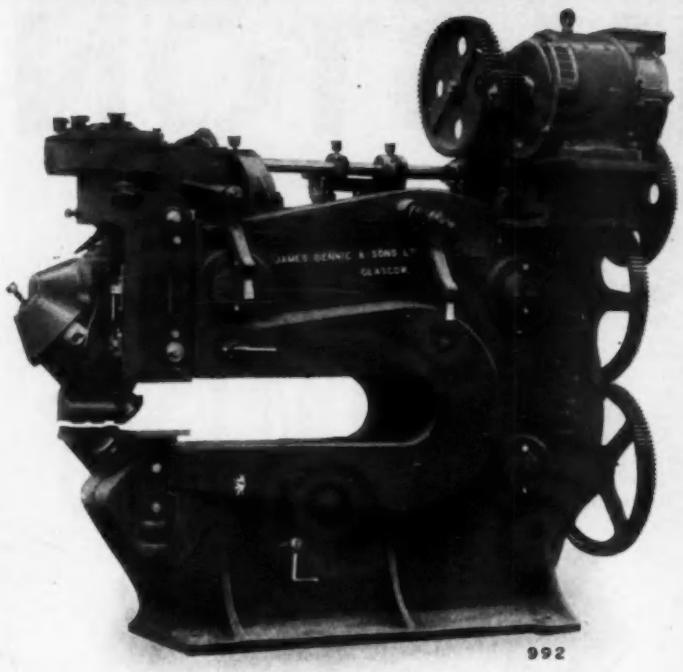

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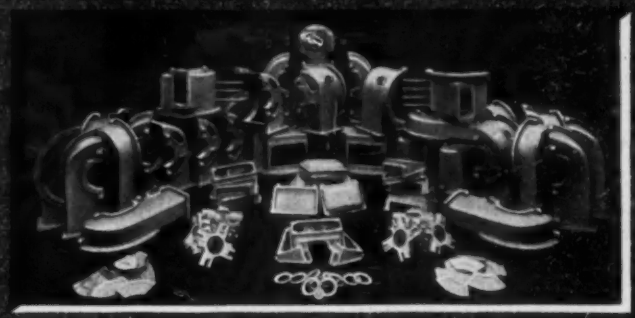

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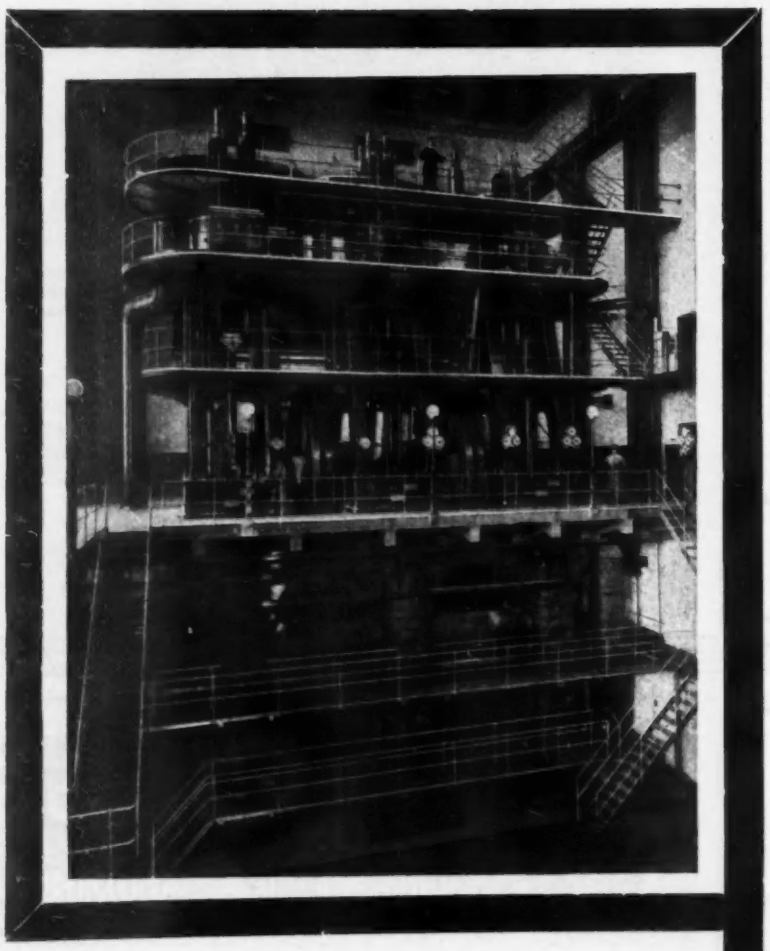

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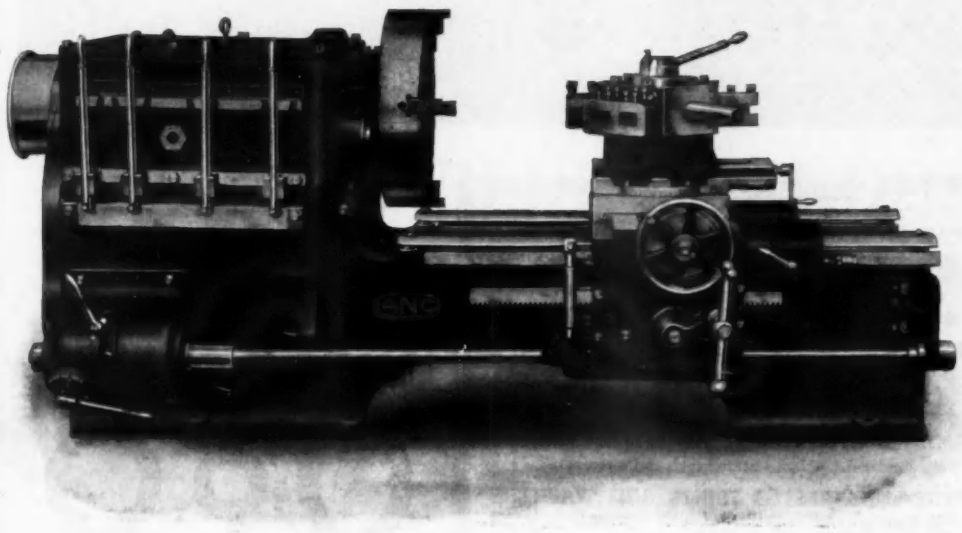

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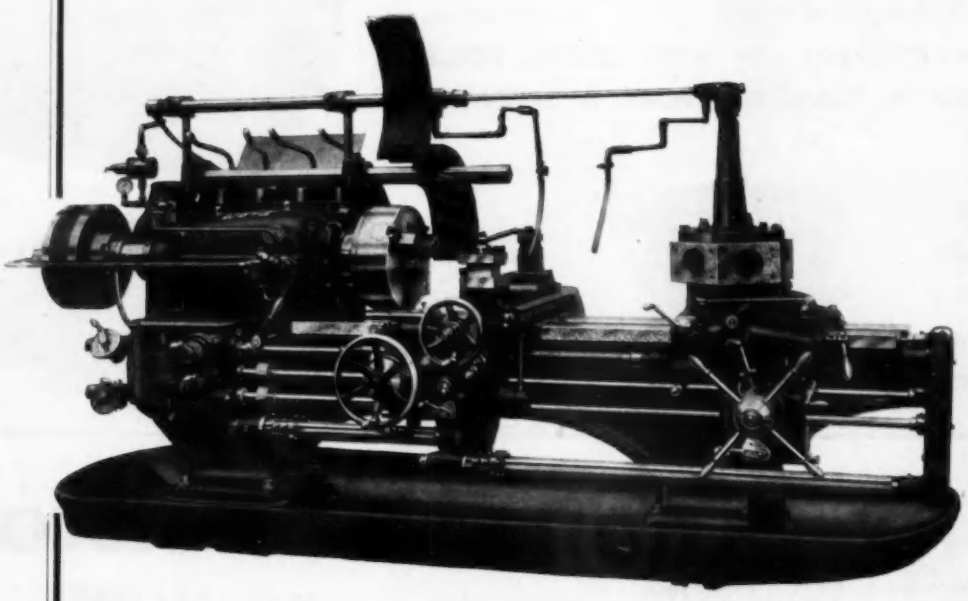

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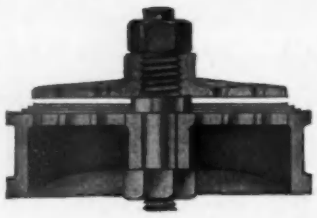

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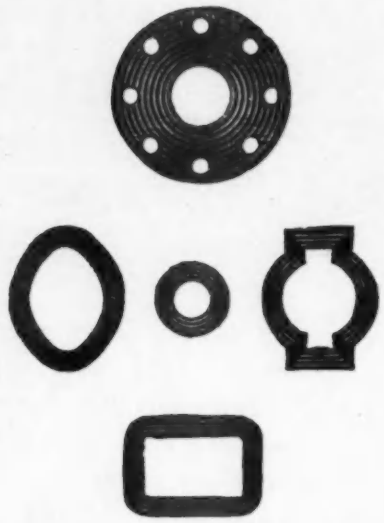

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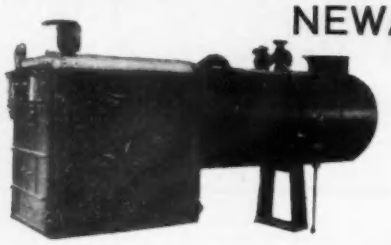

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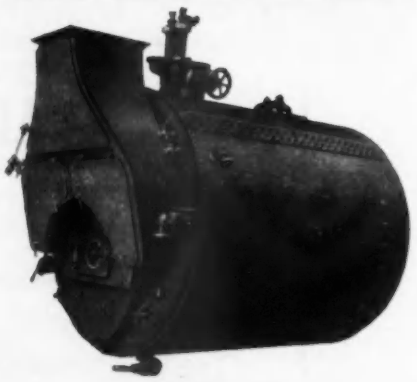

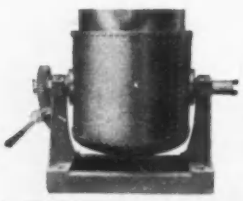

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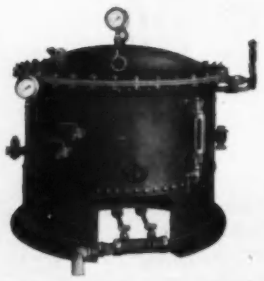

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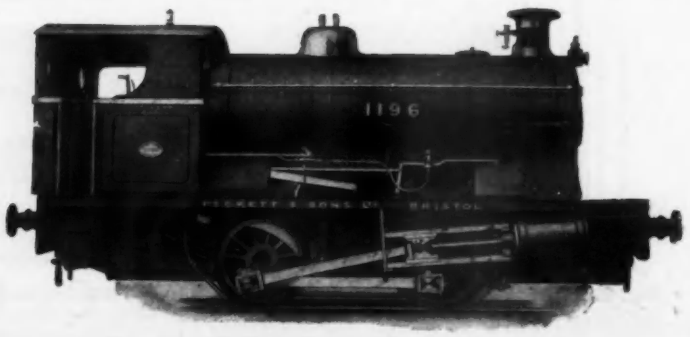

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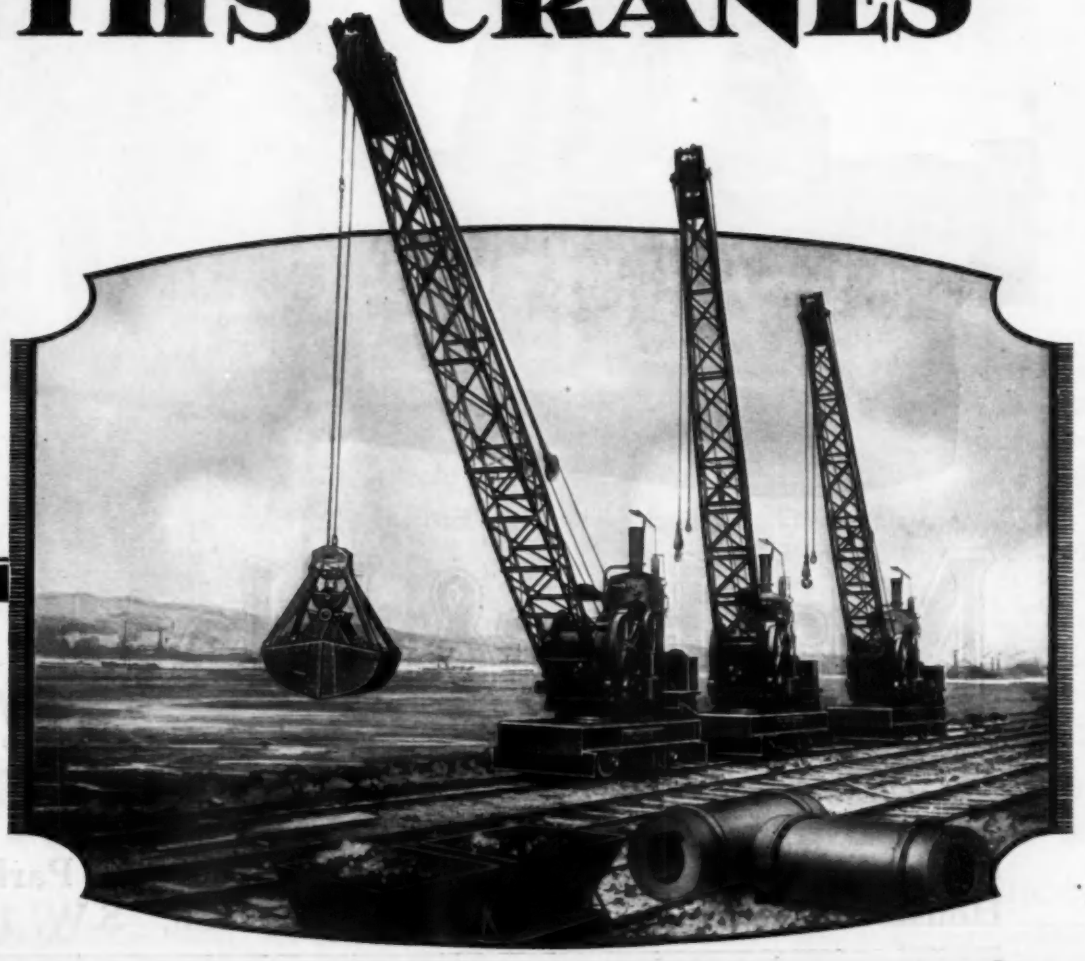

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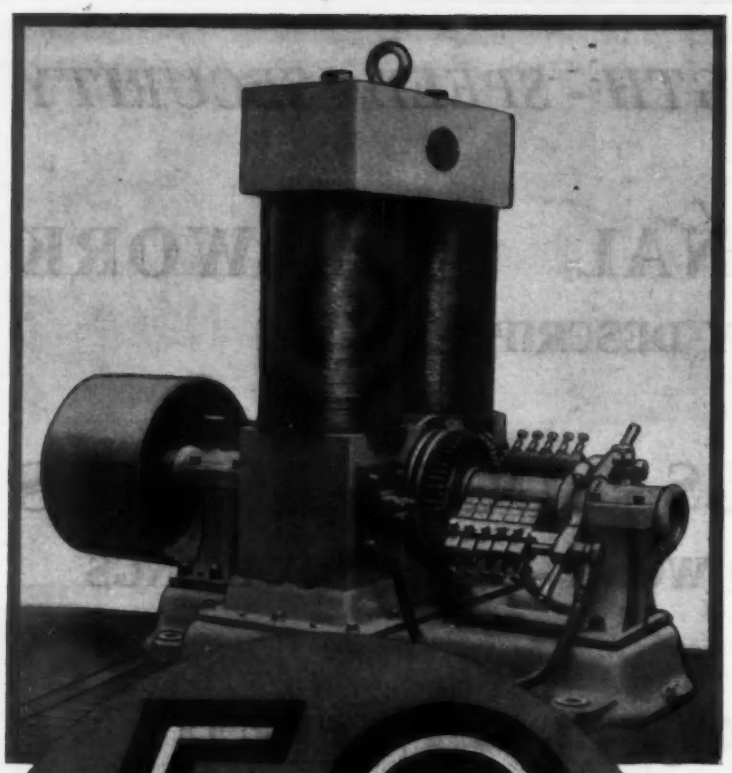

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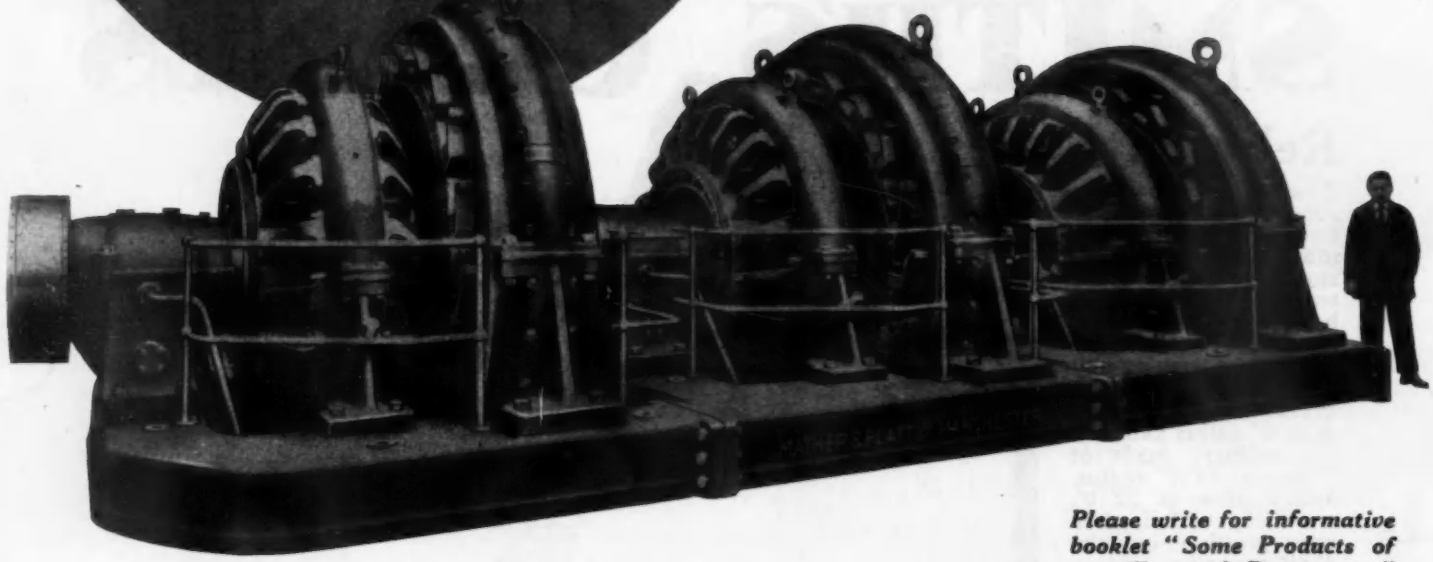

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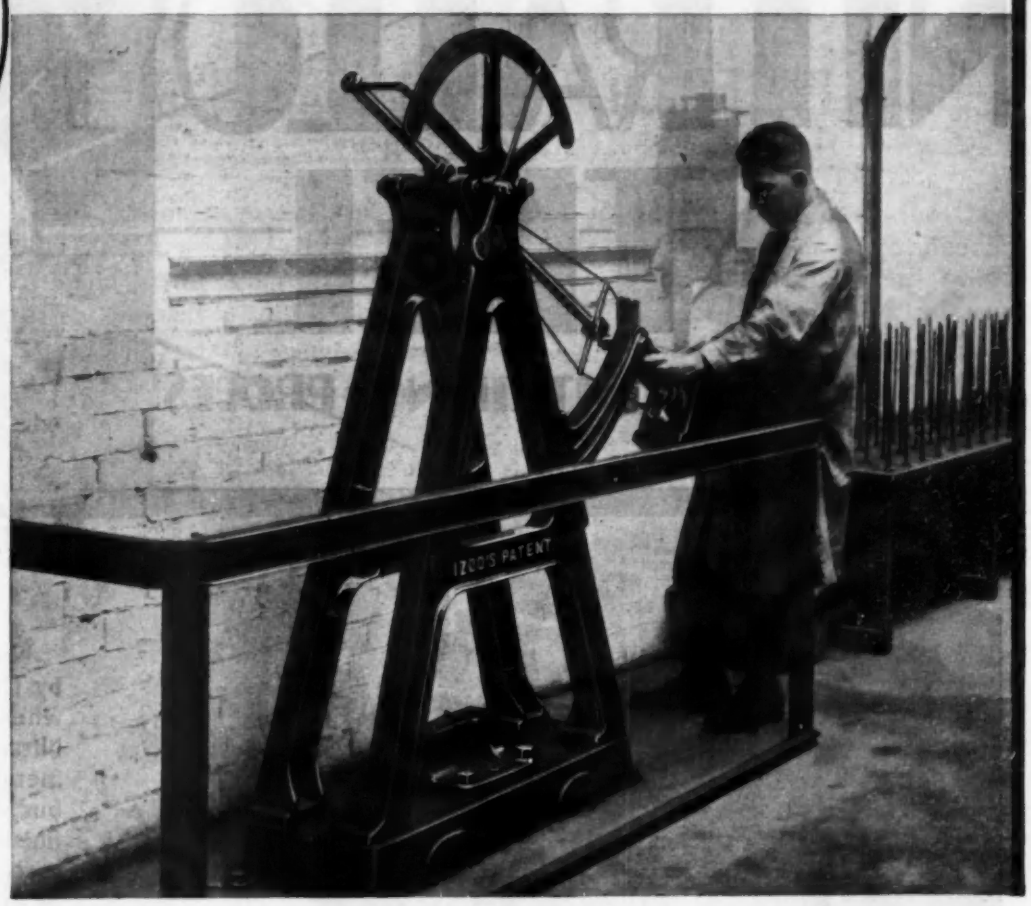
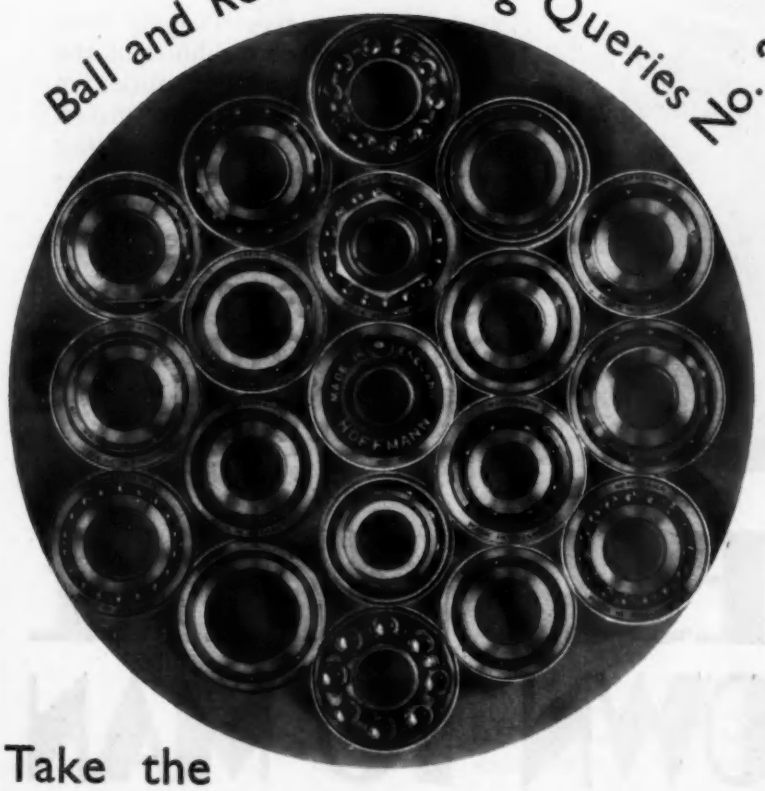


Ball and Roller Bearing Queries No. 2



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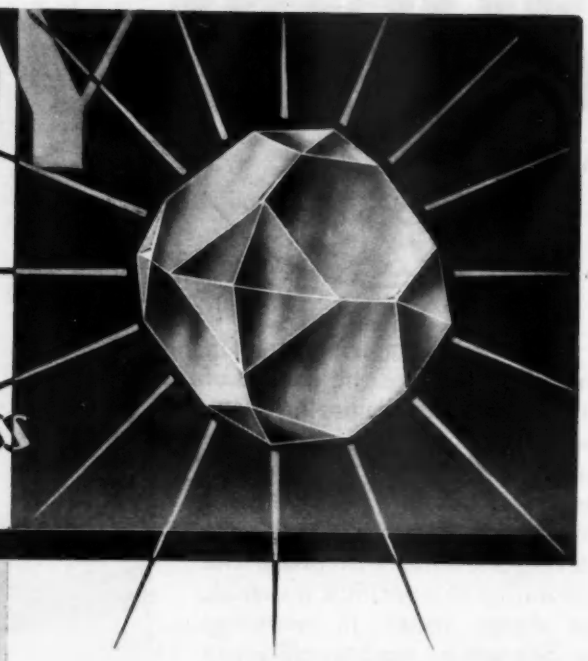

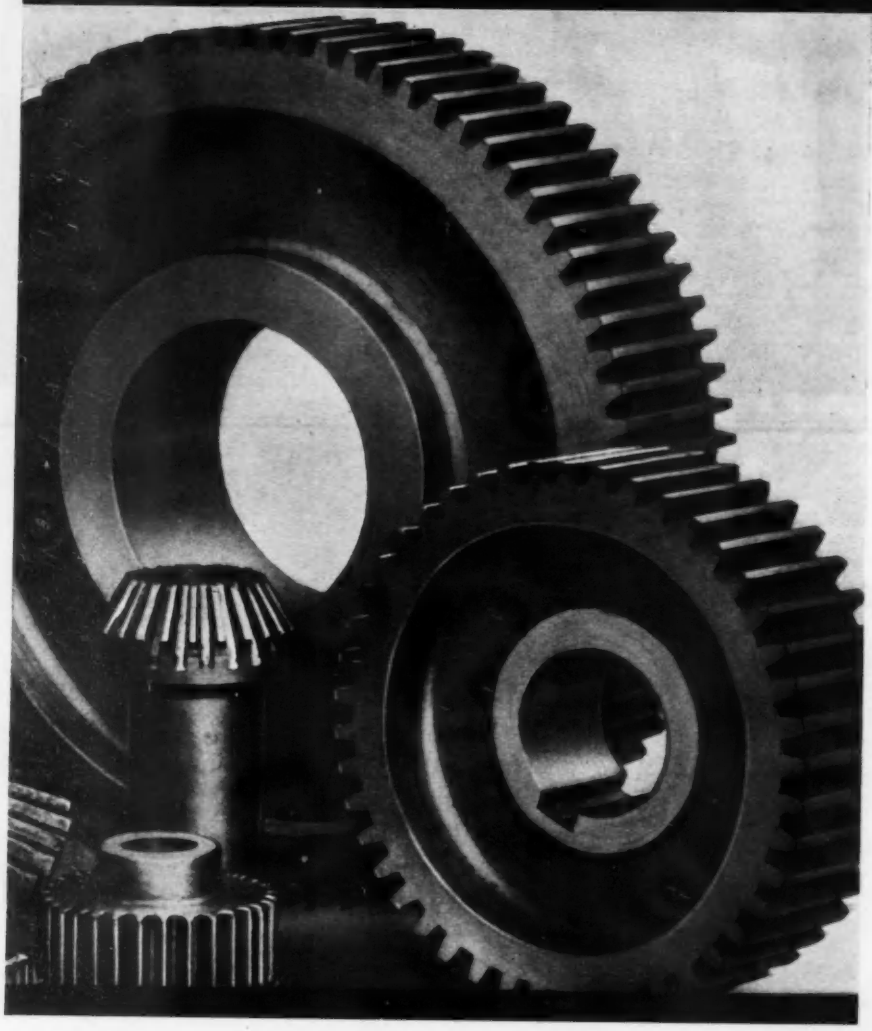

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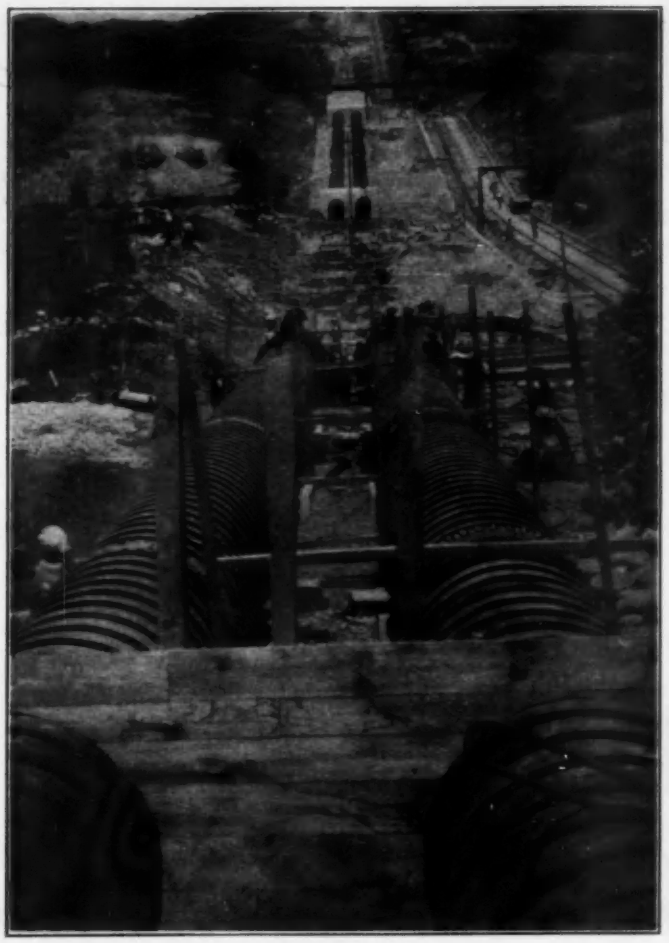

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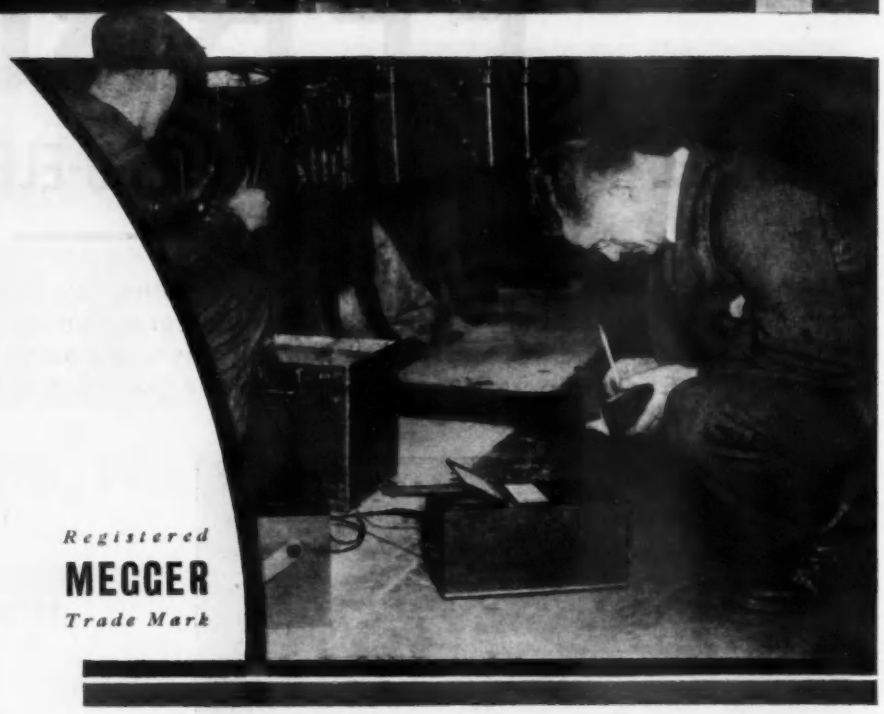

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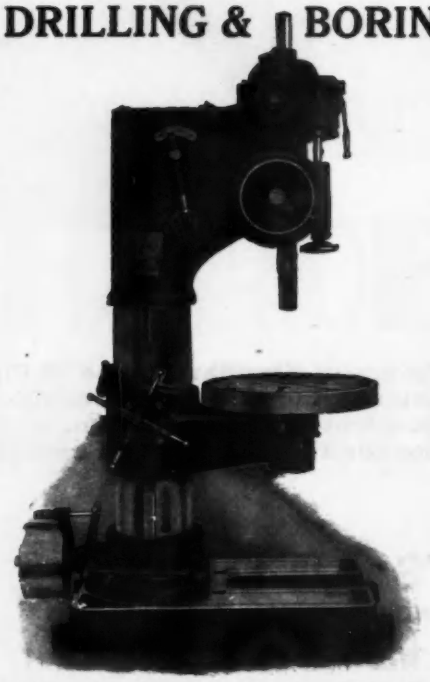

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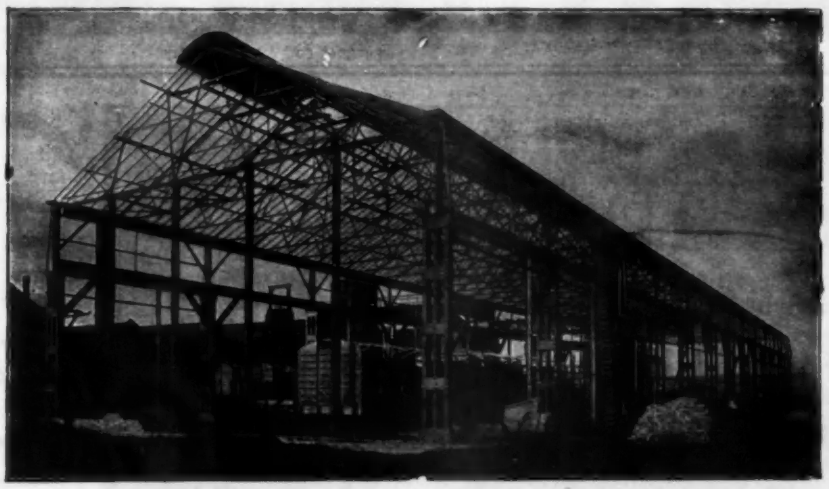

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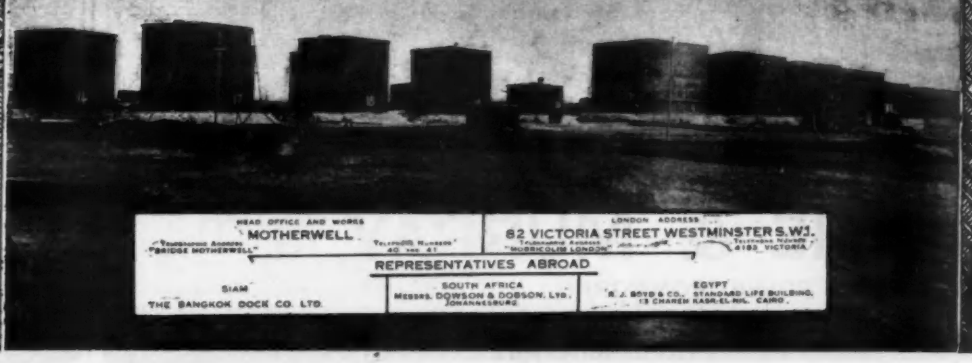

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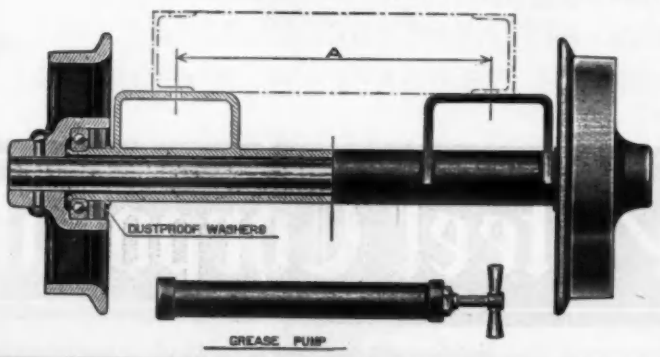

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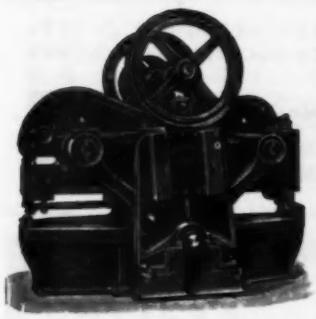

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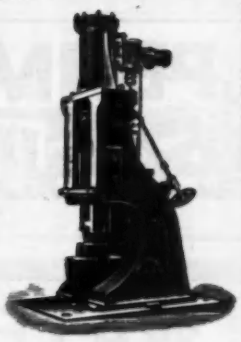

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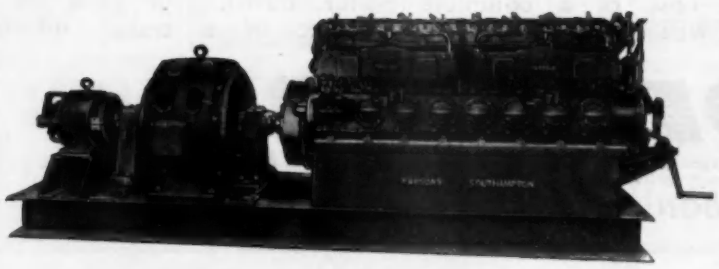

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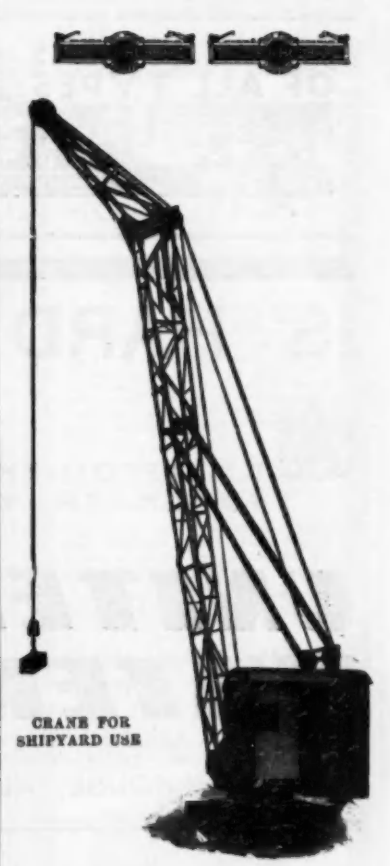

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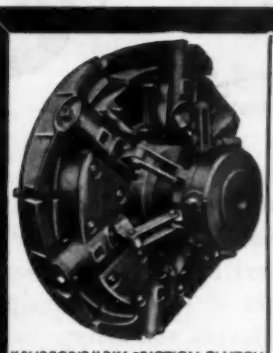

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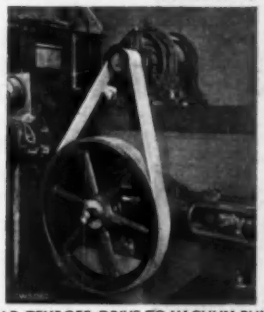

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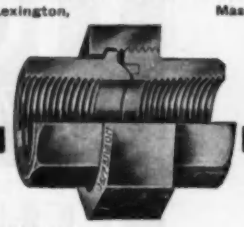

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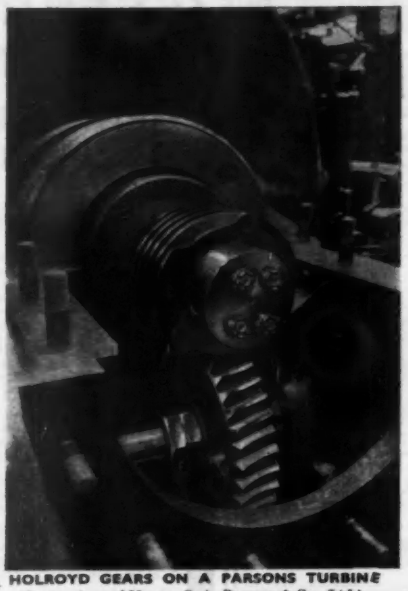
We have over twenty-five years' experience in Pneumatic Tools, Air Compressors and similar machines, and can supply every possible form of Portable tool worked by compressed air, together with all equipment, from a simple hose clip to a complete shipyard plant. We shall be pleased to receive enquiries or a visit to No. 1, Victoria Street (close to Westminster Abbey) and to give advice as well as the fullest information in the matter of Pneumatic Equipment. Any special problems will be thoroughly investigated and designs submitted.



HOLROYD GEARS ON A PARSONS TURBINE
(By courtesy of Messrs. C. A. Parsons & Co., Ltd.)

SILENT, SAFE, SATISFACTORY WORM DRIVES . . .

We specialise in high speed worm drives. Speeds up to 10,000 R.P.M. of the worm—peripheral speeds up to 10,000 feet per minute—are everyday matters with us. Holroyd design, Holroyd materials, and Holroyd accuracy are phenomenal, and we believe it is impossible to obtain a better than a Holroyd worm drive.
Our recent World Record of 97·6% efficiency at the N.P.L. proves this.

There is a very select clientele of worm gear users who have realised that Holroyd worm gears are better than others. If you are not amongst this class of users we suggest that you write for full particulars, and put your worm gear problems before us.

Holroyd-Walker WORM GEARS.

THE GEARS OF THE AGE !
With the New Form of Tooth.

JOHN HOLROYD and CO., LTD., MILNROW, LANCS.

A BRITISH BLADE & FRAME WITHOUT A RIVAL.

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A BRITISH BLADE AND FRAME WITHOUT A RIVAL

Owing to their rigidity and uniformity, "Eclipse" All-hard blades are preferred by skilled mechanics for hand use.

Obtainable from all Tool Dealers

Made by

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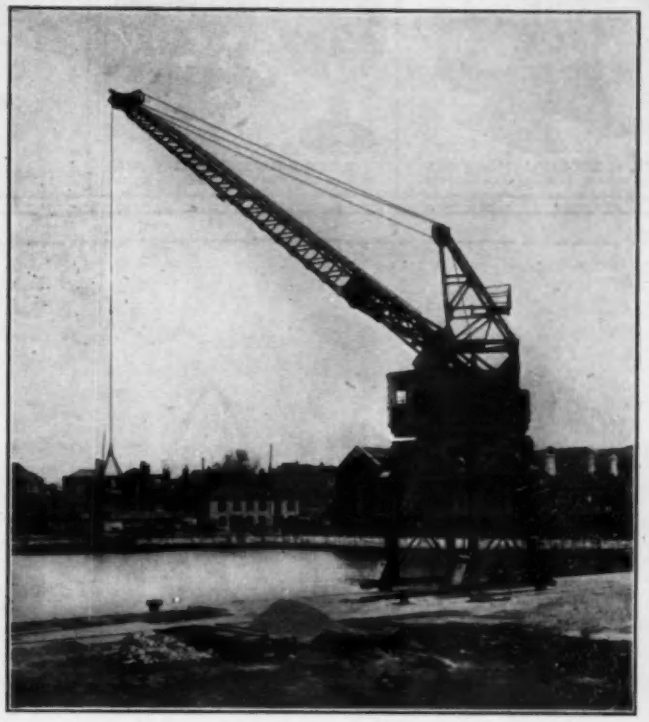
EH 28c

ARROL
CRANK-OPERATED LEVEL-LUFFING
CRANES



3-Ton Electric Crank-Operated Level-Luffing Crane.

SIR WILLIAM ARROL & CO. LTD.
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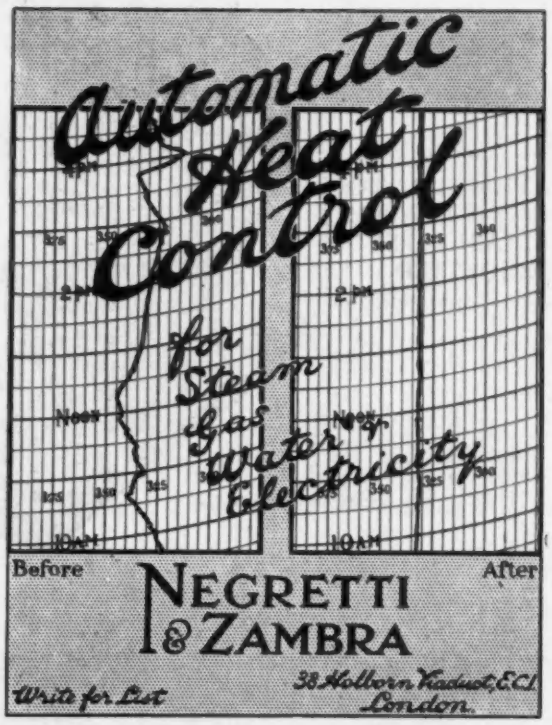
HYDRAULIC MACHINERY
OF EVERY DESCRIPTION.

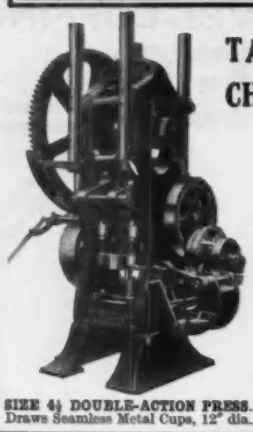
200 Ton Veneering Press.

THE
HYDRAULIC ENGINEERING
COMPANY LTD.
CHESTER AND LONDON.

BROWN BAYLEYS
AUTOMOBILE STEELS
FOR BACK AXLES, PROPELLER SHAFTS, GEARS, &c.
BROWN BAYLEY'S STEEL WORKS LTD., SHEFFIELD.



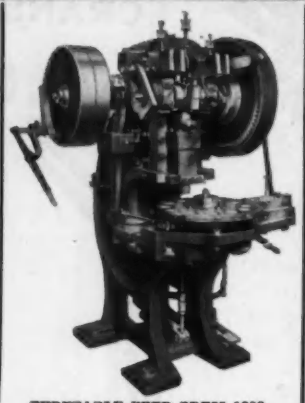
TAYLOR & CHALLEN PRESSES



SIZE 4½ DOUBLE-ACTION PRESS.
Draws Seamless Metal Cups, 12" dia.

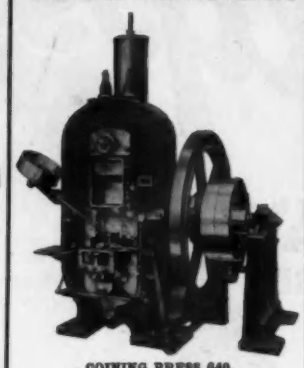
TAYLOR & CHALLEN Ld.

DOUBLE ROLL FEED PRESS 1318.
Produces 1600 Chain Link Blanks per min.



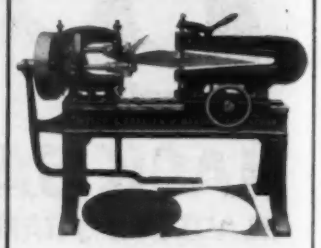
TURNTABLE FEED PRESS 1332.

COMPLETE MINTING PLANTS



COINING PRESS 640.

ENGINEERS & MAKERS.
BIRMINGHAM



ALL SIZES.

128 B CIRCLE SHEARING MACHINE.

Wallwork

Special High Ratio Enclosed Gears.

TO

TO
1
R.P.M.

The illustration represents one of these gears as recently supplied, the combination of worm and special spur gear being clearly shown, the top cover being removed for this purpose.

RATIOS UP TO 1000 TO 1 WITH VARIABLE SPEED IF REQUIRED.

FROM
2,500 R.P.M.

HY. WALLWORK & CO., LTD.,
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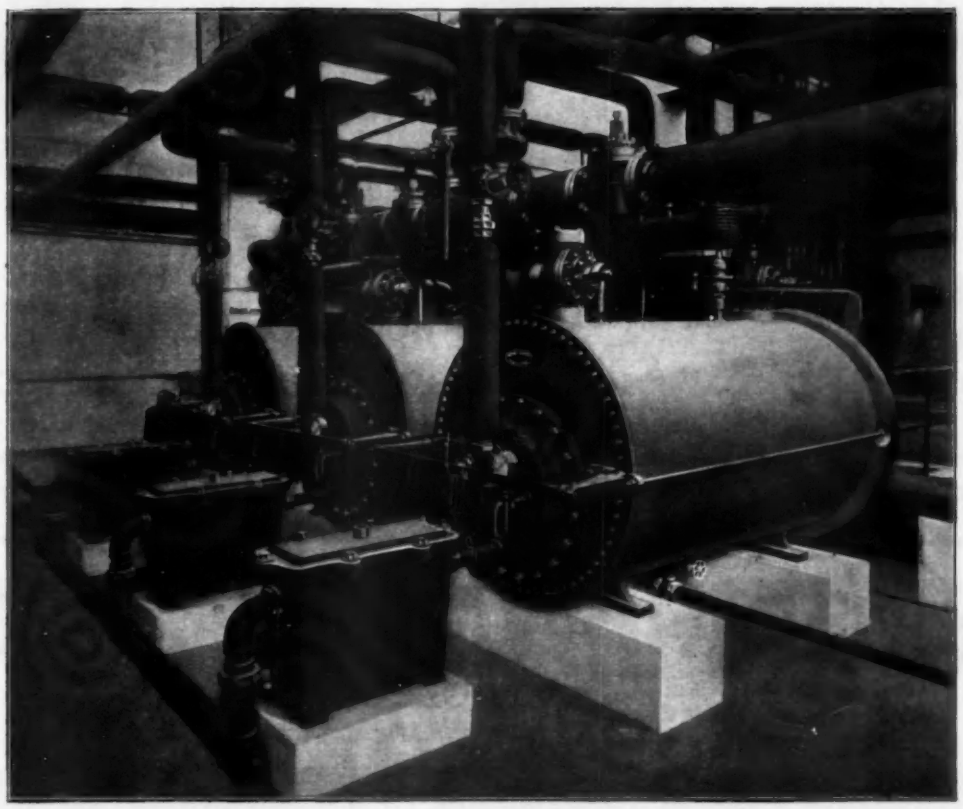
ROYLES

CALORIFIERS

ROW'S PATENT

FOR THE **HEATING** AND **HOT WATER SUPPLIES** OF
HOTELS, PUBLIC and INDUSTRIAL BUILDINGS, SHIPS, &c.



TYPICAL ARRANGEMENT OF HOT WATER SUPPLY CALORIFIERS.

The illustration shows a battery of Storage Calorifiers with interconnecting pipes, valves and steam traps and forms one of many schemes recently designed and carried out in conjunction with Heating Engineers, for some of the newest and largest Hotels, Industrial Office Buildings, and Institutions.

We are always ready to assist those responsible for the planning of such schemes, by placing at their disposal an accumulated experience extending over many years.

ENGINEERS AND SPECIALISTS.

Royles Limited
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D.C. Automatic Electric Control Gear

'ELEVANJA'
Automatic
Switch Gear
for the control of
Electrically Driven
Lifts, Cranes, Hoists,
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ELLISTON, EVANS & JACKSON, Ltd.,
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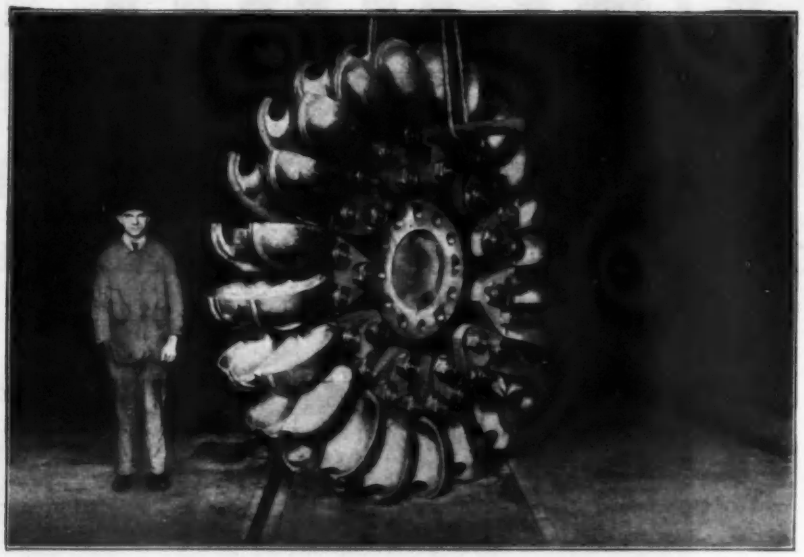
THE MOST POWERFUL BRITISH BUILT PELTON RUNNERS

The photograph shows one of 4 Pelton Runners of 17,000 B.H.P. each under a head of 1700 feet for the Shanan Power Station of the Uhl River Hydro-Electric Development, Punjab, India,



These wheels are being built at the Works of Markham & Co., Ltd., Chesterfield, to our designs and specifications, and are the most powerful Single Wheel Pelton Turbines ever built in Great Britain.

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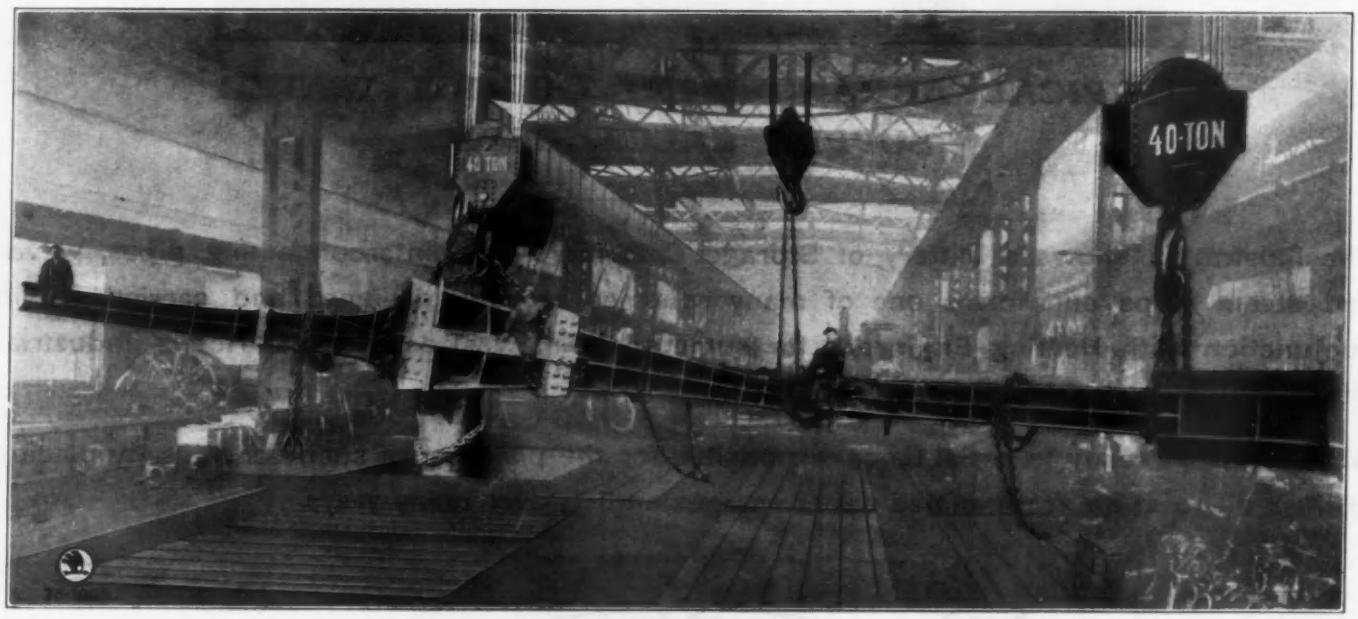
ŠKODA WORKS LTD
PRAGUE :: CZECHOSLOVAKIA.



C.S. Sternframe and Propeller Bracket, assembled, total nearly 60 tons.

STEEL CASTINGS and FORGINGS for SHIPBUILDING a SPECIALITY.

Agents in United Kingdom—

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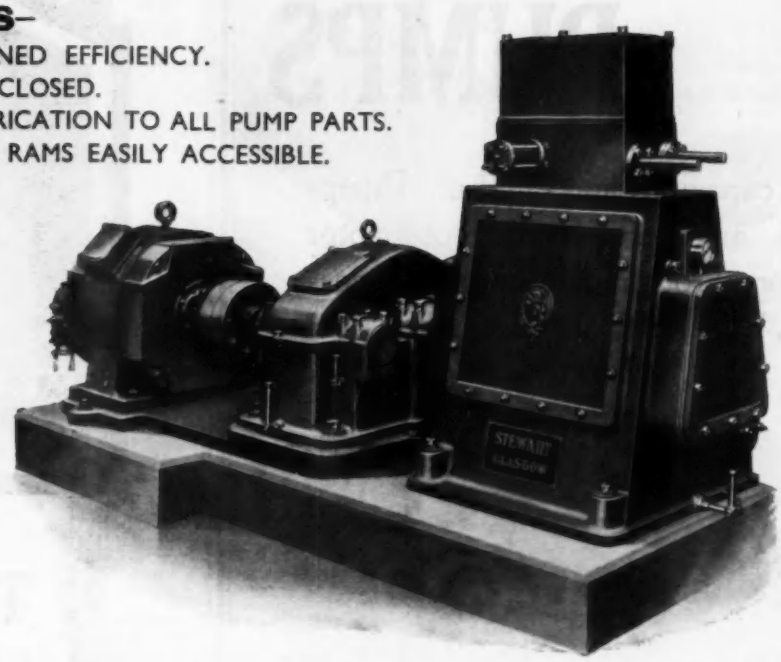
VERTICAL HIGH SPEED TRIPLE RAM PUMP

SPECIAL FEATURES–

HIGH COMBINED EFFICIENCY.
TOTALLY ENCLOSED.
FORCED LUBRICATION TO ALL PUMP PARTS.
VALVES AND RAMS EASILY ACCESSIBLE.

This pump on test had a volumetric efficiency of 96·5% at 4000 lbs. pressure per sq. inch.



DUNCAN STEWART & CO., LTD.,
LONDON ROAD IRONWORKS,
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"DAVY" LANCASHIRE BOILERS
FOR LONG SERVICE.

Lancashire Boilers are very similar in construction and appearance, but there is a very considerable difference in the service obtained from them.

Having been supplied to the leading Collieries, Steel Works, Factories, Etc., for more than 50 years, "Davy" Boilers have gained a high reputation for soundness of construction and long service. We are constantly receiving reports of highly satisfactory working for long periods. It will pay you to adopt "Davy" Boilers.

Built to any size or for any pressure and with flat or dished ends.

9'-0" × 30'-0" LANCASHIRE BOILER.

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Established 1830.

Telephone: Sheffield 22161 (5 lines)
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We also Manufacture :

"DAVY" HIGH-SPEED FORGING PRESSES.
MODERN ROLLING MILLS FOR COGGING, PLATES, BARS, SECTIONS, TYRES, Etc.
"MORGAN" CONTINUOUS ROLLING MILL PLANTS.
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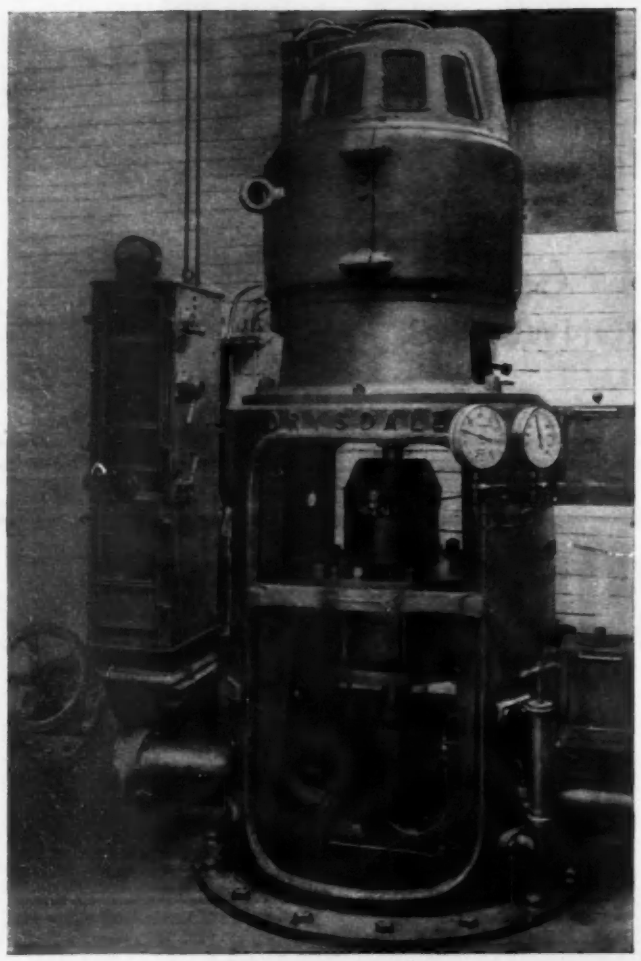
STEAM HAMMERS, "BLAKE" WASTE HEAT BOILERS.
STEEL CHIMNEYS AND TANKS, GENERAL ENGINEERING WORK, Etc.
"FIRTH STAYBRITE" VESSELS AND TANKS.

BOREHOLE PUMPS

For all capacities and depths. Pumps can be arranged for direct motor drive, or through belt or gear transmission, or by any form of steam, gas or oil engines.



FOR CHEAP & PURE WATER SUPPLY, BRINE WELLS, Etc.

The most economical pump because it can be adapted to existing boreholes, gives maximum yield and high efficiency, the depth of pumping can easily be increased, occupies small space, requires only cheap foundations, is simple to instal and the maintenance cost is negligible.

DRYSDALE & COMPANY, LTD.
YOKER,
GLASGOW.

The World's biggest Floating Crane

THE self-propelled Floating Crane illustrated above proves the capability of Messrs. Cowans Sheldon for solving all lifting problems, from the smallest up to those of the greatest magnitude.

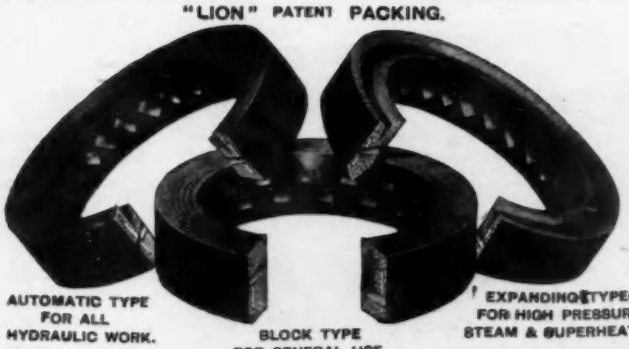
This Crane will revolve through a complete circle with loads of 350 tons at 100 ft. radius, with a lift of 140 ft. The main loads are lifted on two independent blocks of 175 tons capacity each, which can be used either independently or coupled together. An auxiliary purchase of 50 tons gives a total lift of 200 ft., while a trolley of 50 tons capacity travelling on the underside of the jib gives a horizontal travel of 75 ft. This obviates the need to use the derricking motion for small loads.

COWANS SHELDON & CO. LTD. CARLISLE

"LION" PACKING

(PATENT)

"LION" PATENT PACKING.



AUTOMATIC TYPE FOR ALL HYDRAULIC WORK.

BLOCK TYPE FOR GENERAL USE.

EXPANDING TYPE FOR HIGH PRESSURE STEAM & SUPERHEAT.

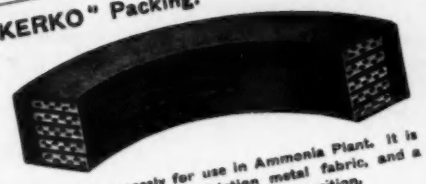
"ROVER" Packing.

A staple Grease Packing, designed for use in Rotary Pumps. Special yarn is used in manufacture.

"WALLICO" Cone Gauge Glass Rings.

Especially suitable for High Pressure and High Temperature Steam. "WALLICO" Rings will not go hard.

"KERKO" Packing.



Designed expressly for use in Ammonia Plant. It is a combination of Anti-friction metal fabric, and a special Flake Graphite Composition.

"LION" JOINTS.

"LION" Metallic Joints for Boiler and Handhole doors. Steam Gland Joints, etc. Supplied in enormous quantities to leading Railway Companies, etc.

"WALLICO" Rod Packing

A popular Semi-metallic Packing for General Steam use, the anti-friction metal being interwoven with the fabric.

ENQUIRIES INVITED for Packings and Jointings for all Purposes and Pressures.

Write for Illustrated Catalogue No. 220.

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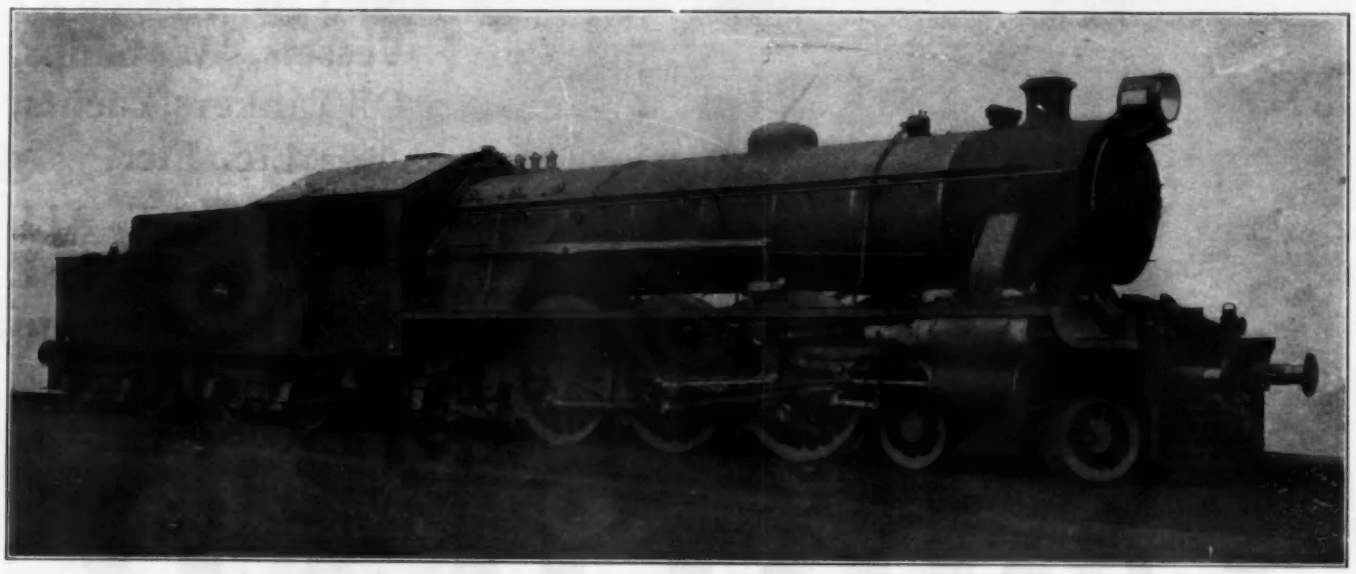
"LION" IS THE KING OF PACKINGS — REFUSE ALL IMITATIONS.

NORTH BRITISH LOCOMOTIVE CO., LTD., GLASGOW.

BUILDERS OF ALL TYPES OF

LOCOMOTIVES



4-6-2 TYPE

TWO CYLINDER PASSENGER LOCOMOTIVE FOR THE 5' 6" GAUGE

H.E.H. THE NIZAM'S GUARANTEED STATE RAILWAYS (Messrs. RENDEL, PALMER & TRITTON, Consulting Engineers)

Cylinders 21½" x 28" — Heating Surface 2303 sq. ft. — Tank 4500 gals.
Coupled Wheels 6'-2" — Grate Area 45 „ „ — Fuel 450 cub. ft.
Total Weight E & T = 155 tons. — Weight per coupled axle, 17 tons.
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THE LARGEST AND MOST EXPERIENCED BRITISH MAKERS OF

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Designers and Constructors of all classes of Mail & Passenger Vessels, Warships, Oil Tankers, Yachts, Etc. Etc.

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Constructors of all classes of Constructional Steelwork, Bridges, Wagons, Etc.

MODERN EQUIPMENT FOR PROGRESSIVE ECONOMY

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Photographs show :-
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Recently completed at our Works.

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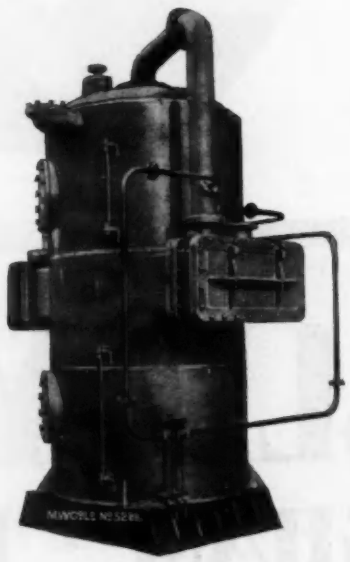
EXPERIENCE ESTD 1793 EFFICIENCY

'Mirrlees'
FROM TURBO EXHAUST TO BOILER



The De-aerator.

Boiler Tube Corrosion

THE higher temperatures now ruling in boiler plant are emphasising tube corrosion troubles due to oxygen and carbon dioxide being liberated in the water.

The "Mirrlees" combined De-aerator and Heater gets rid of these gases before the feed water reaches the boiler. It does not consist merely of heating under vacuum, but of two distinct stages.

A list of installations and sample test chart will be sent on request

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ENGINEERS, 45, Scotland Street, GLASGOW
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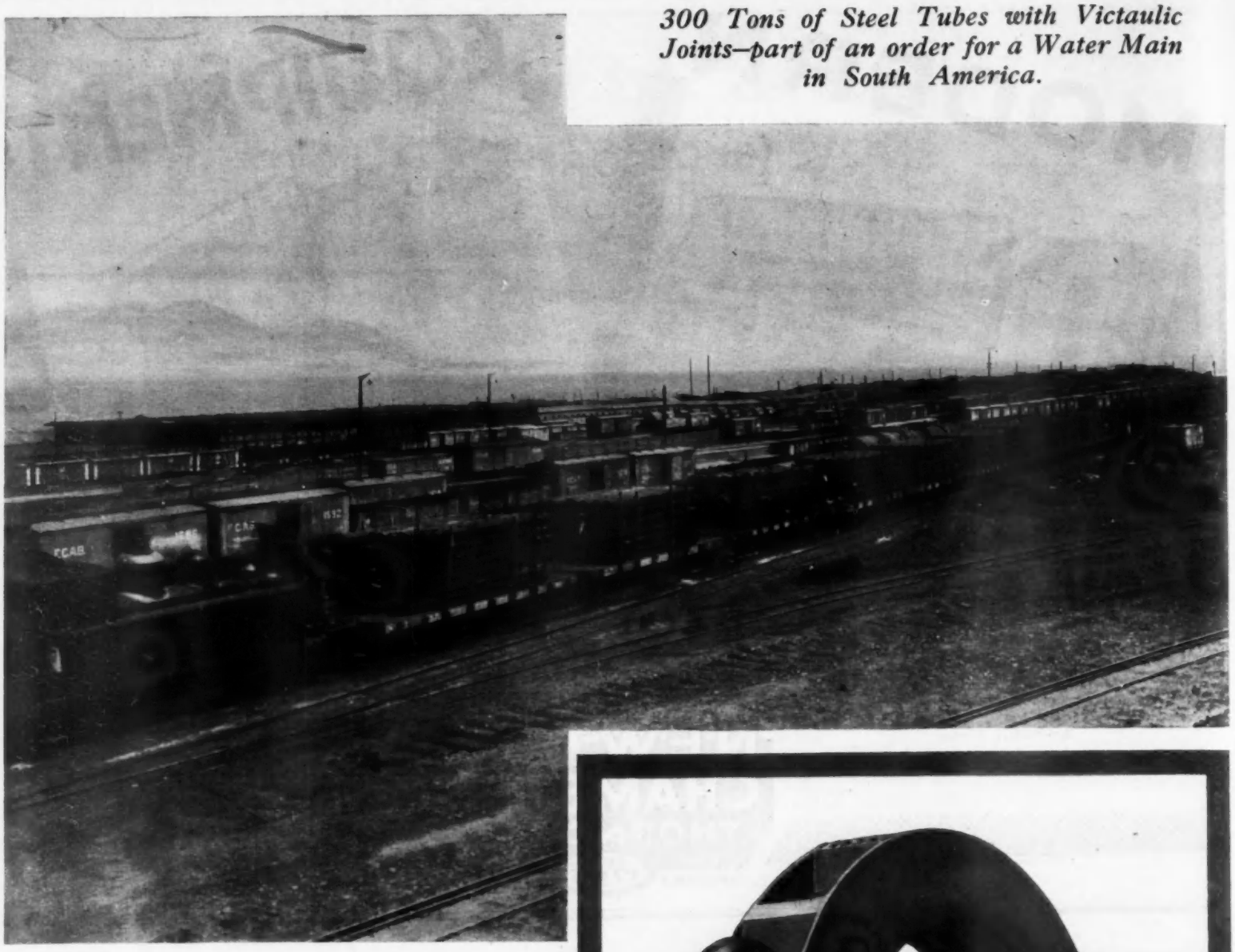
300 Tons of Steel Tubes with Victaulic Joints—part of an order for a Water Main in South America.



Victaulic Joints mean ease and rapidity in laying, flexibility in alignment, freedom from stresses arising from expansion and contraction, and automatic leaktightness.

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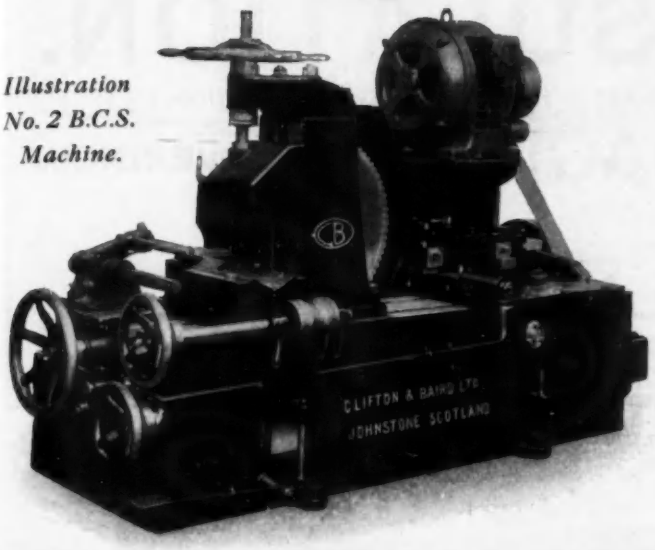

Illustration No. 2 B.C.S. Machine.

Made in sizes 20″ to 60″ dia. of Saw.

Actual Cutting Times

4″ dia. M.S. Bar	25 secs.	Joists	
6″ ,, ,,	1 min.	15″×6″	1 min.
9″ ,, ,,	3½ mins.	24″×7½″	1½ mins.
12″ ,, ,,	6 mins.	95 Rail	1 min.

"A Cold Saw that is a Modern Machine Tool."

CLIFTON & BAIRD, LTD.,
Empress Works, Johnstone, Scotland.

Branch Offices: Associated British Machine Tool Makers, Ltd., London, Birmingham, Manchester, Newcastle, Glasgow, Leeds, Calcutta, Paris, Brussels, &c.

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THE MIDLAND IRON CO., LTD.

Makers of
GENUINE WROUGHT IRON
in accordance with B.E.S.A.'s requirements.

OUR MANUFACTURES INCLUDE:

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Flats.	Rounds.	Squares.
Angles.	Convex.	Gothics.
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Gibsons Key.	Chamfered Bars.	One Round Edge.
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Concave and Grooved Shoe Bars.

HOOPS and STRIPS for coopering, packing and baling.

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BRIGHTON - 3 TONS ELECTRIC HORIZONTAL LUFFING JIB CRANES WITH COAL GRABS

85%
MAGNESIA INSULATION.

HIGH TEMPERATURE COVERINGS. SLABS, SECTIONS, PLASTIC HARD SETTING COMPOSITION.

SPECIFY "DARLINGTON MAGNESIA" COVERINGS.

MADE BY THE WELL-KNOWN PATTINSON PROCESS.

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SUPER-VITRITE

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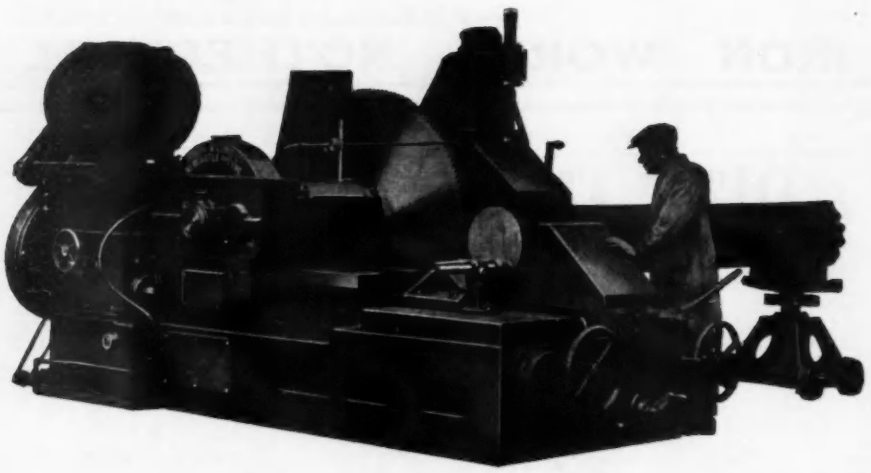
HARDENS IN AIR OR OIL.

Howell & Co Ld BROOK STEEL WORKS Sheffield.

HEAVY DUTY COLD SAWING MACHINES.

MODEL C.S. 3.



The illustration shows a large machine fitted with 60" diameter blade.

The Saw teeth are formed in segments of high speed steel ensuring maximum production.

We have machines cutting steel billets up to 20" square section in 65/70 tons tensile steel.

These machines are made for rapid cutting of steel bars, billets, girders, rails, etc., and can be supplied in various sizes to meet requirements.

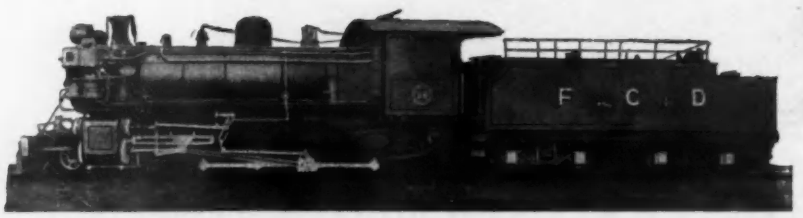
Please send your enquiries to

NOBLE & LUND LTD.

FELLING-ON-TYNE.

R. & W. HAWTHORN, LESLIE & CO., LTD.,

London Office: 54, Victoria Street, Westminster, S.W.1. NEWCASTLE-ON-TYNE.



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Of every description for Home and Foreign Railways.

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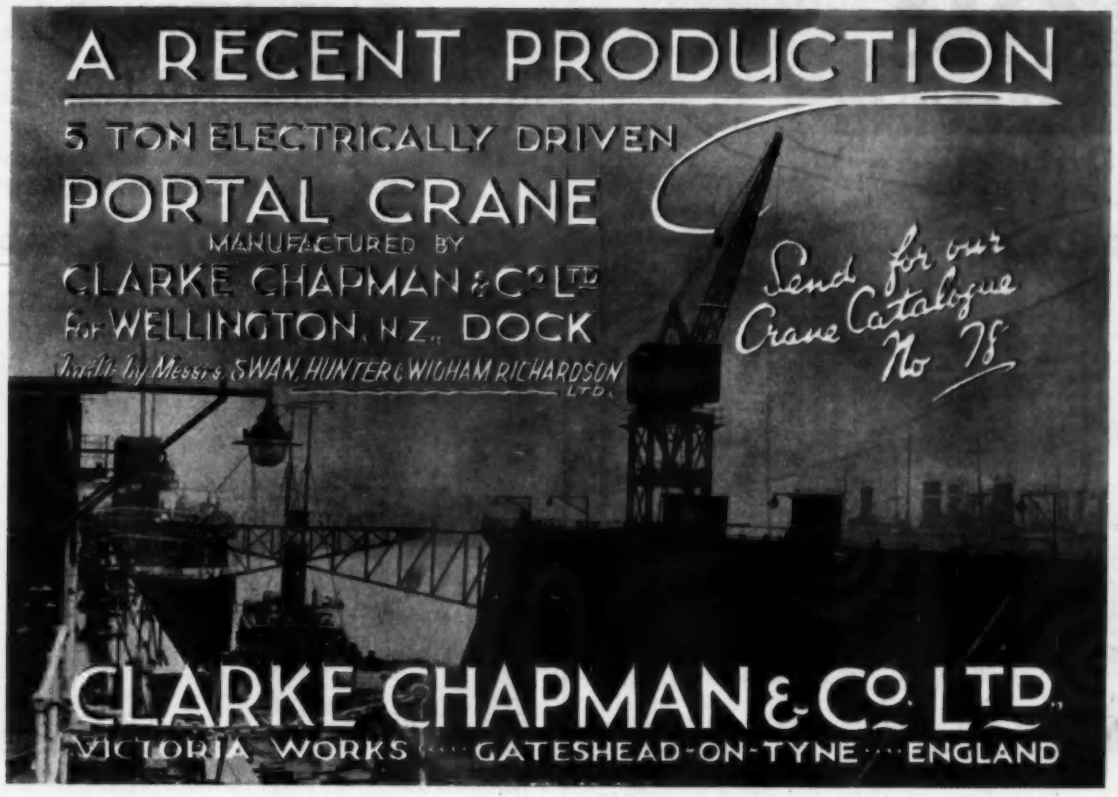
Teleg. Add.—LOCOMOTIVE, NEWCASTLE-ON-TYNE. ESTABLISHED 1817.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5 TON ELECTRICALLY DRIVEN
PORTAL CRANE
MANUFACTURED BY
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FOR WELLINGTON, N.Z., DOCK
BUILT by Messrs SWAN, HUNTER & WIGHAM RICHARDSON LTD.
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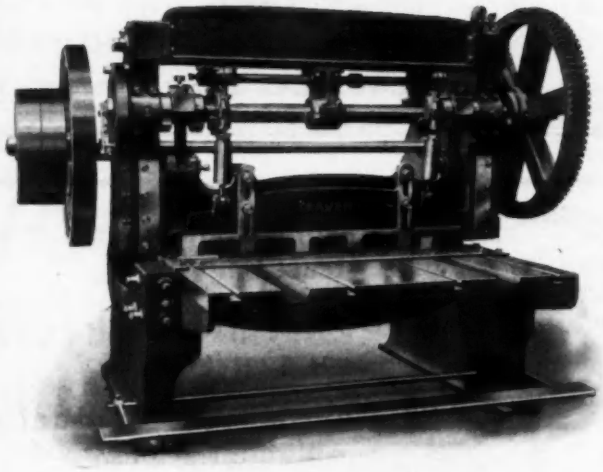

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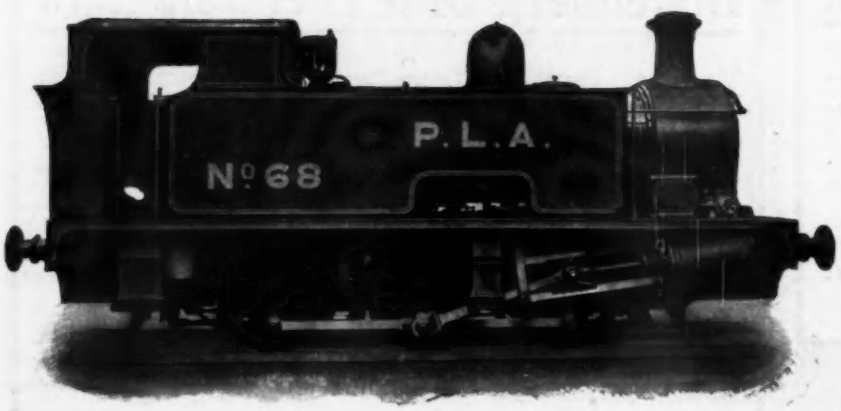

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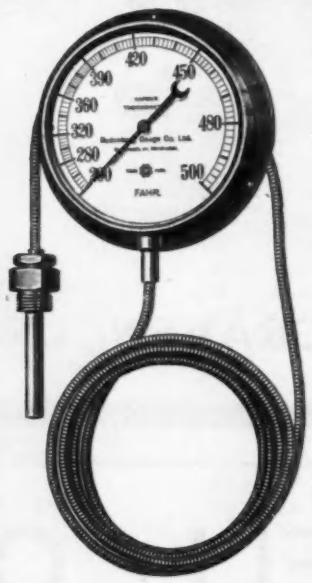

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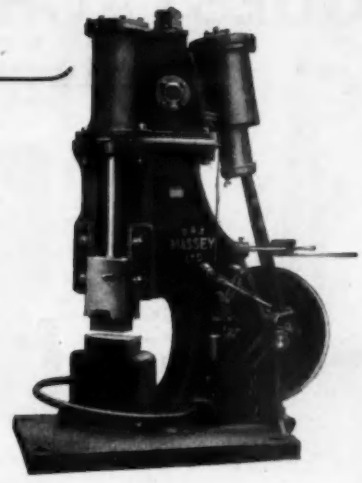

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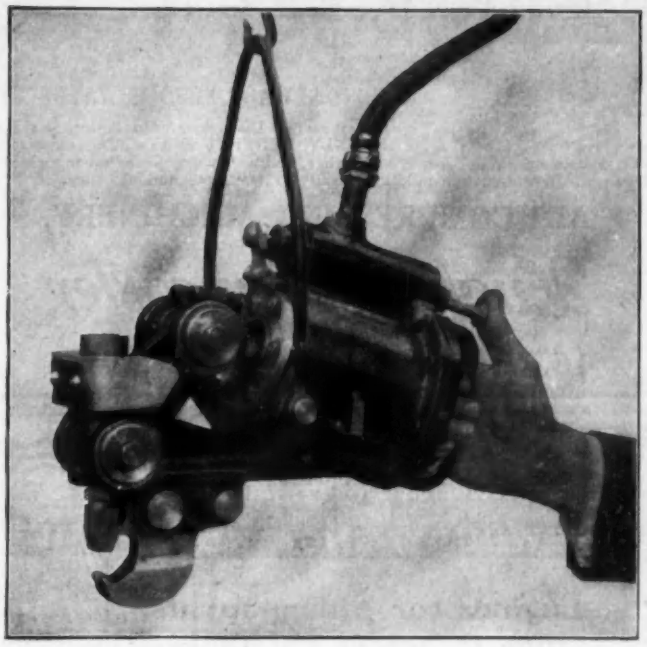

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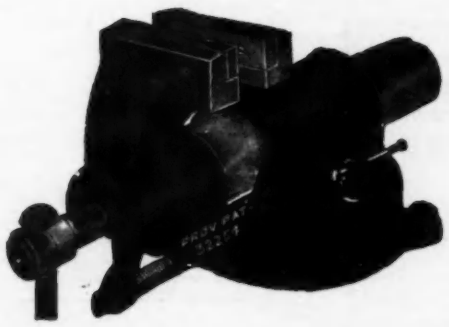

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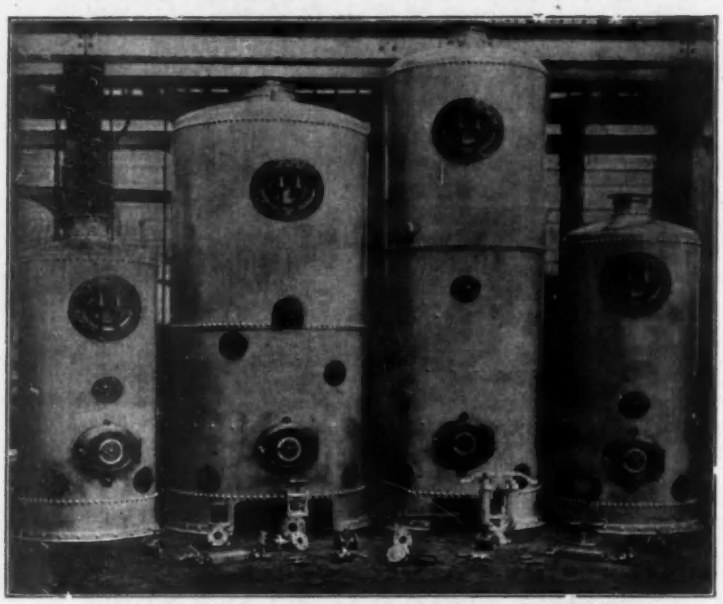

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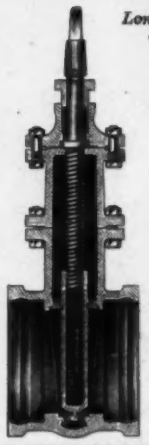

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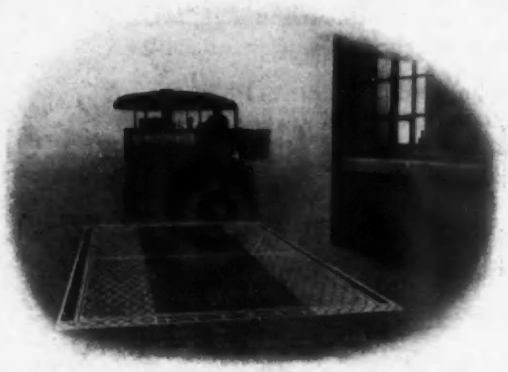

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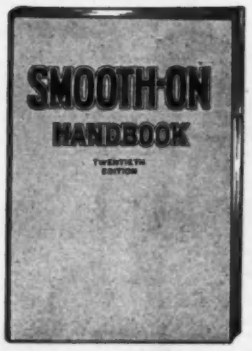

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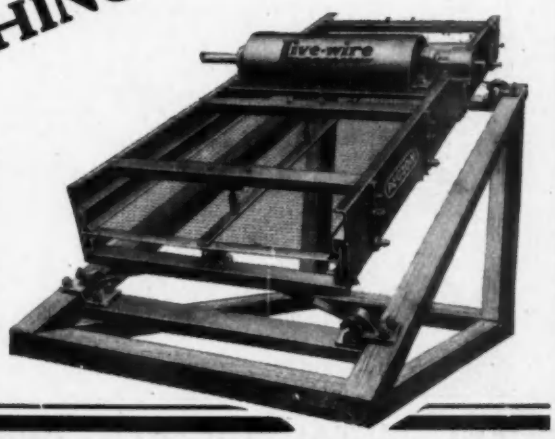

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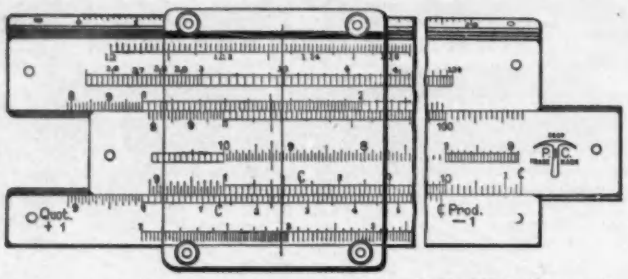

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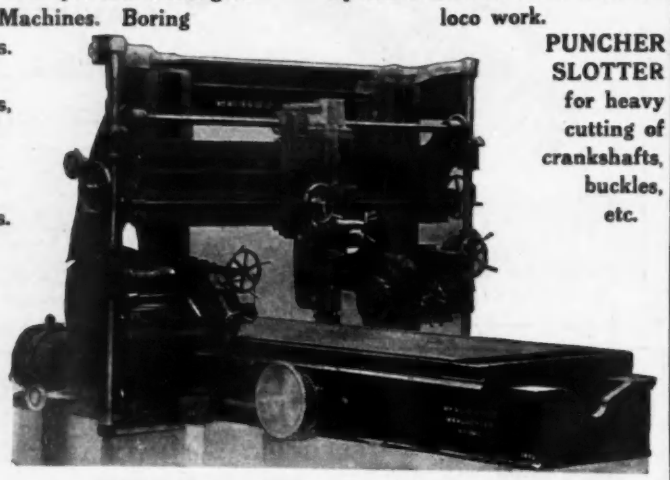

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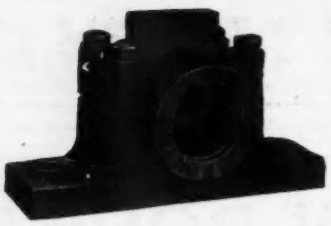

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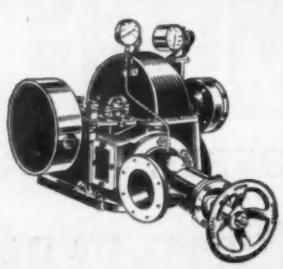

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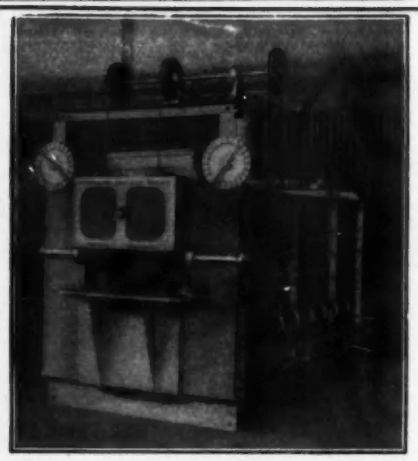

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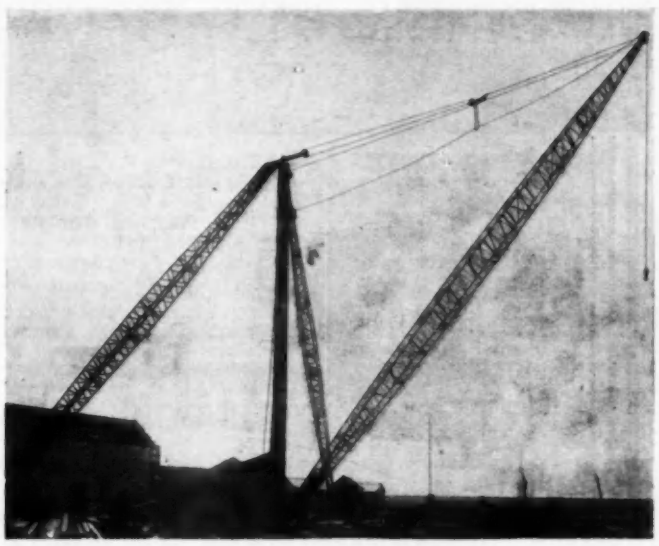

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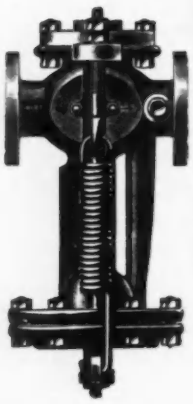

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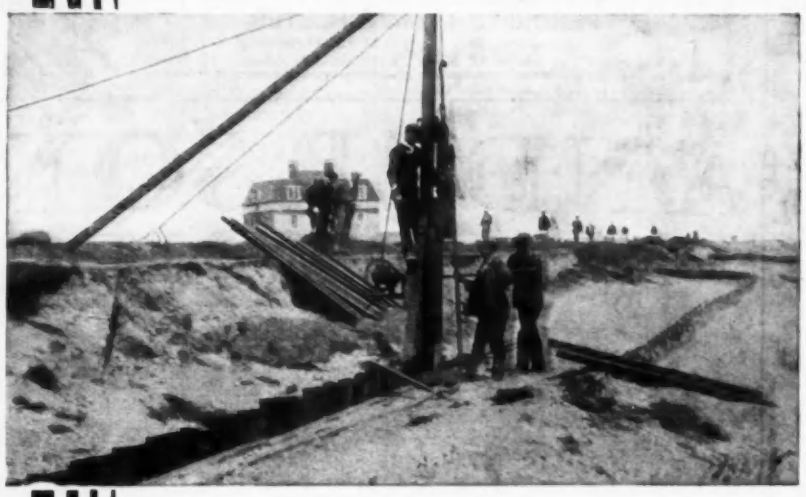

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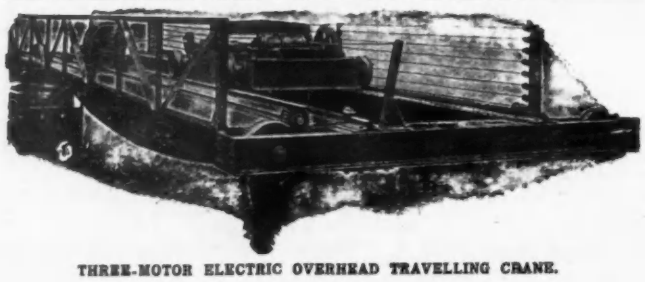

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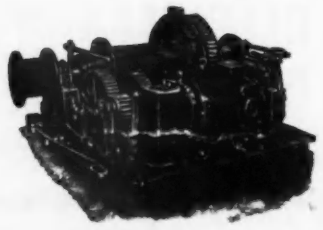

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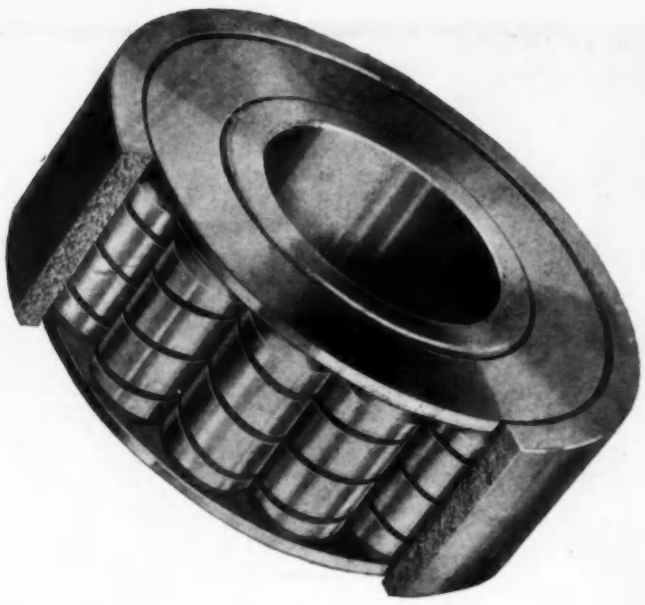

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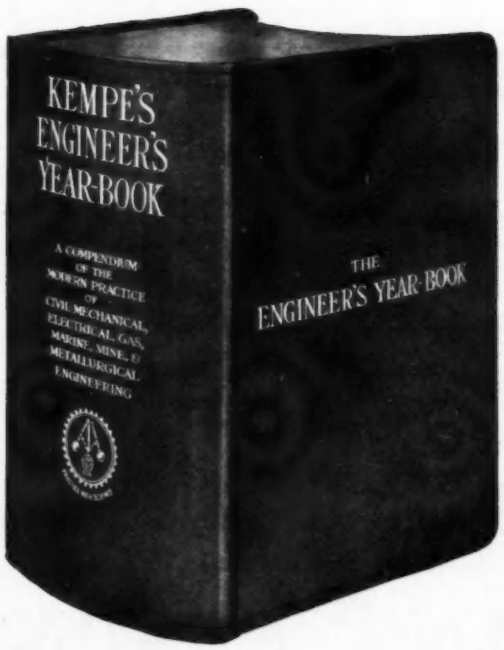

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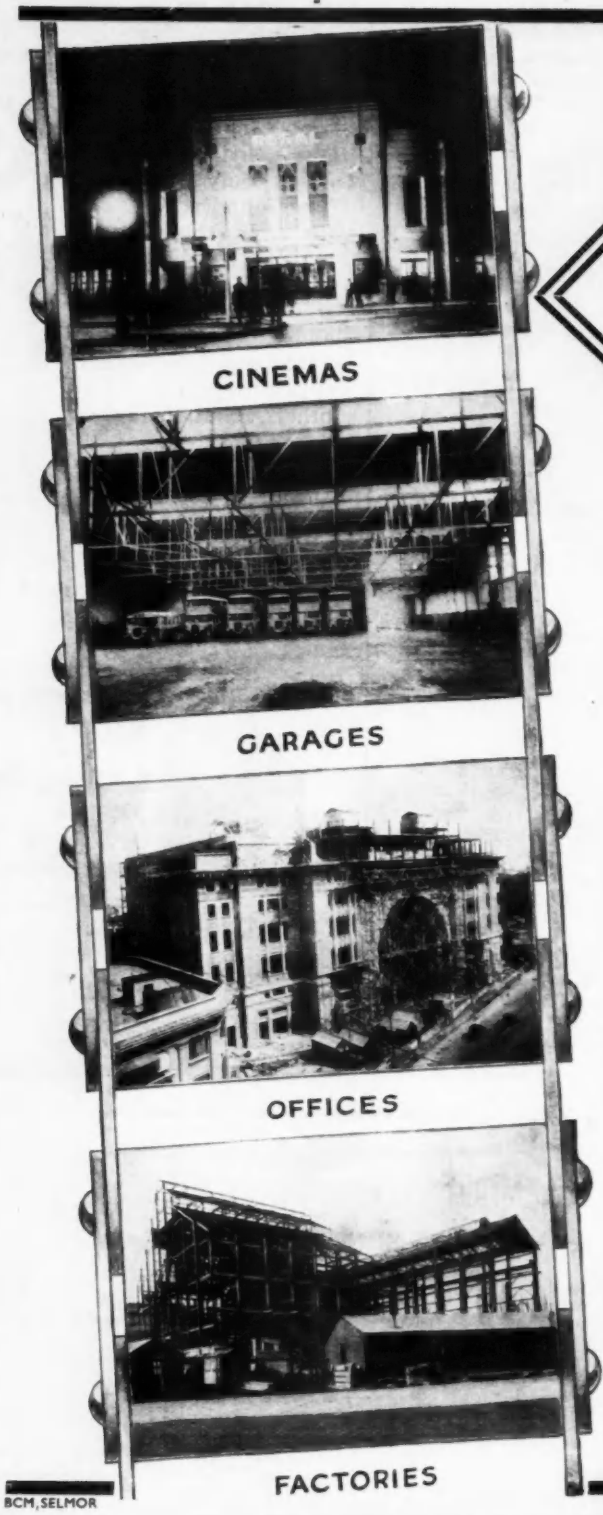

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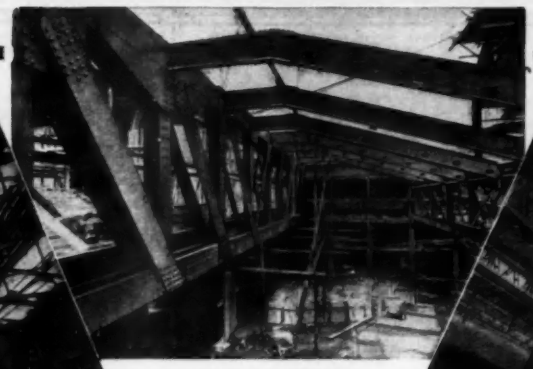

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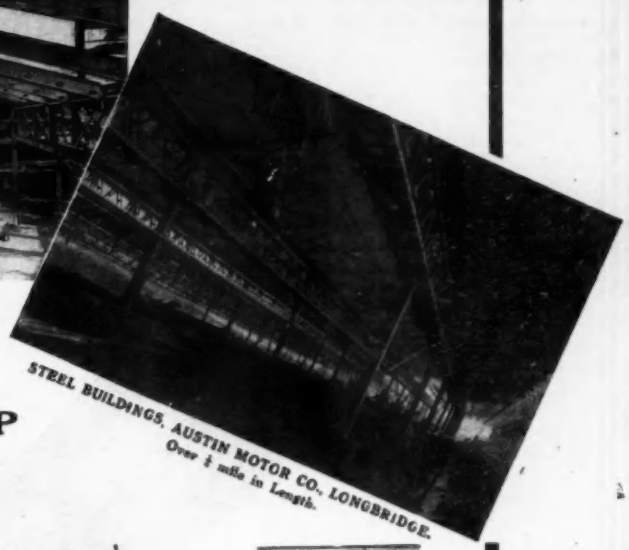

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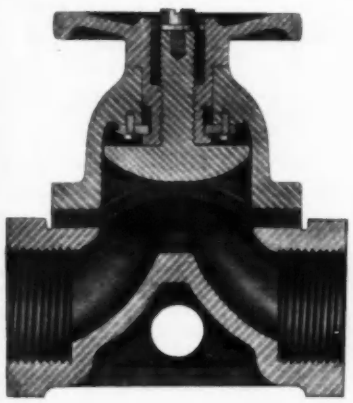

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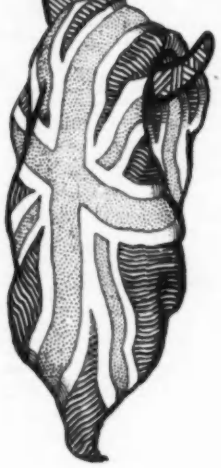

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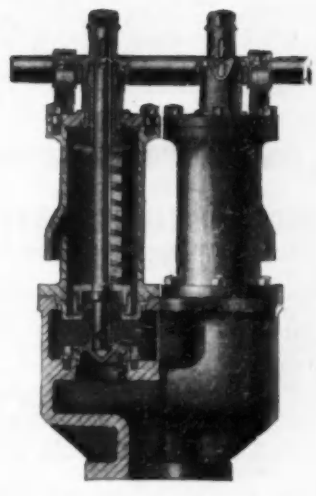

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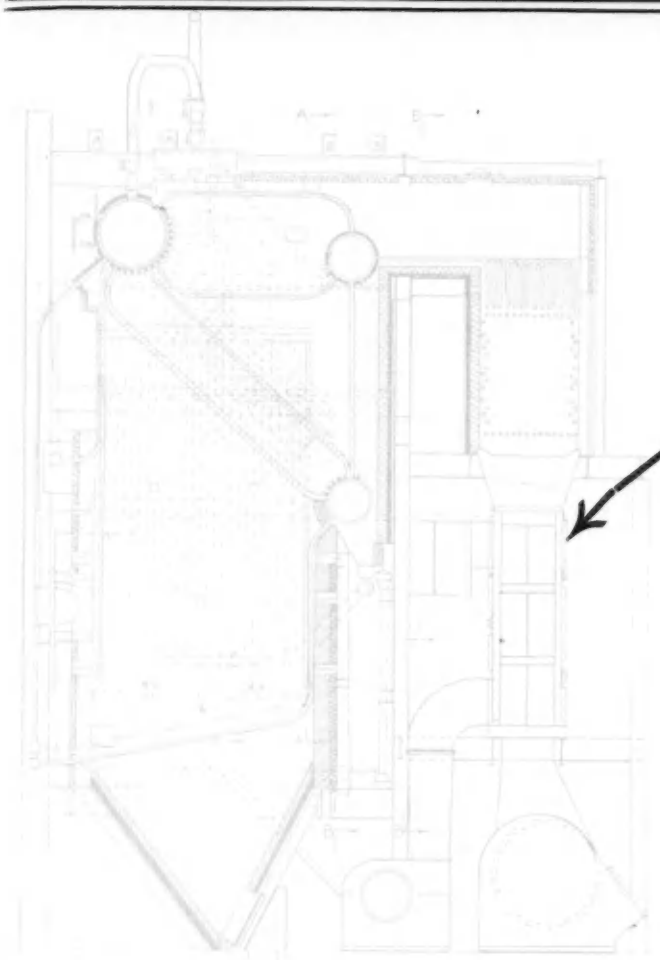

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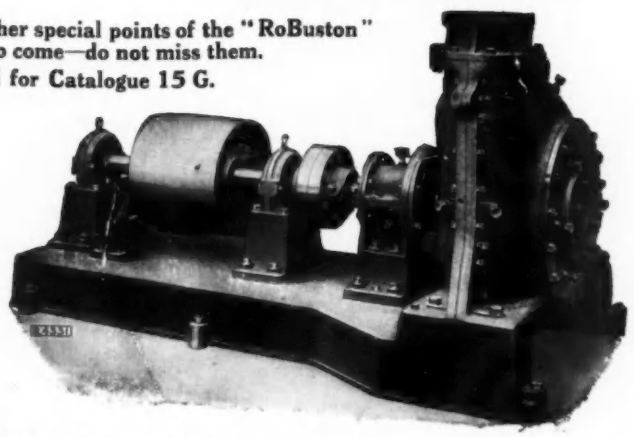

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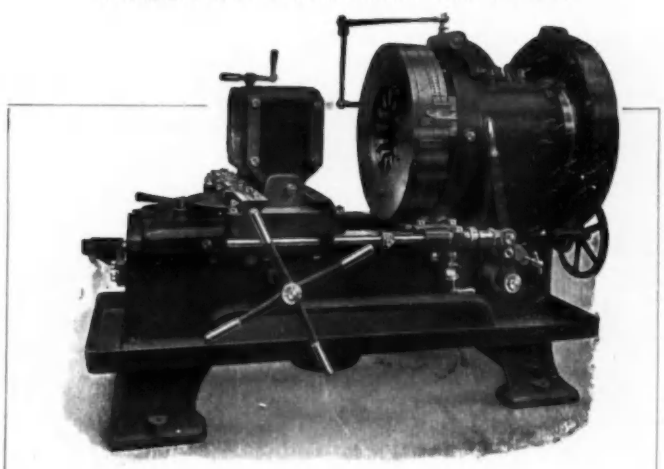

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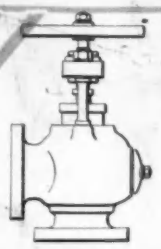
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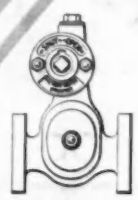
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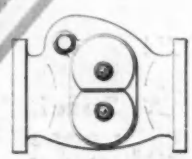
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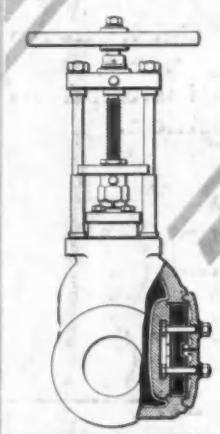
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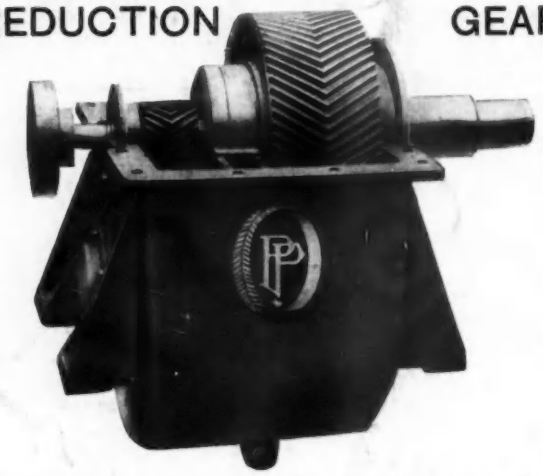

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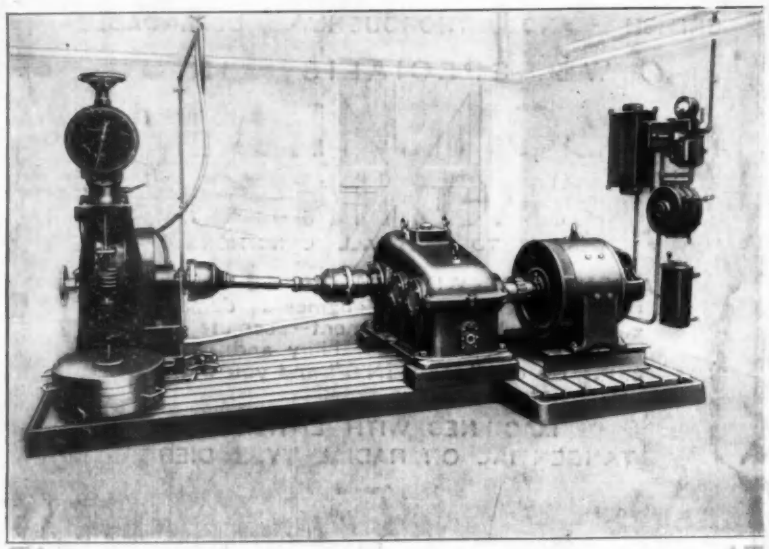

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